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ABSTRACT

Presented is material from an information program designed to help citizen advisory groups and local officials improve decision-making in water quality planning. This program is aimed at helping people focus on essential issues and questions by providing materials suitable for persons with non-technical backgrounds. The following chapters are included: (1) Innovative and Alternate Technologies; (2) Water Conservation and Reuse; (3) Land Treatment; (4) Cost-Effectiveness Analysis; (5) Environmental Assessment; and (6) Financial Management. The volume contains reading material and selected references. (CO)

An Information Program for Advisory Groups

Working for Clean Water

2

Citizen Handbooks

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Preface

This information program is based on the assumption that the reader already has a basic knowledge and awareness of the important life-sustaining role that water plays in the biological, chemical, and physical cycles on the planet Earth If the reader desires this kind of information, your local reference librarian can recommend books that discuss the topic

* * * * * * * * * * * * *

Working for Clean Water is an information program designed to help citizen advisory groups and local officials improve decision-making in water quality planning The idea is simple—the more people know about a subject, the better prepared they are to make workable and practical decisions in meeting community needs This program is aimed at helping people focus on essential issues and questions by providing materials suitable for persons with nontechnical backgrounds Although this material was conceived and developed with the advisory group member in mind, it is useful for many other training situations. Persons benefiting from these water quality management educational materials will be local, state, and federal employees, public school and college students, and wastewater treatment authority members The materials have already been used for these groups and were found to provide an excellent introduction to the subject.

These materials include handbooks, audiovisual presentations (slide/tape or 16 mm film), and instructor guides. The audiovisual presentations highlight major issues and important aspects of each topic The handbooks elaborate on these points, provide additional detailed information, and include examples of how other communities have dealt with water quality and wastewater treatment issues The instructor guides give suggestions on how to hold an information session including guided discussions on local topics of concern and some problem-solving exercises

This volume is one of a series of three which contain the citizen handbook materials The eighteen topics discussed in the individual handbooks are chapters in this three-volume set The chapter topics are

- Role of Advisory Groups
- Public Participation
- Facility Planning in the Construction Grants Program
- Municipal Wastewater Processes Overview
- Municipal Wastewater Processes Details
- Small Systems
- Innovative and Alternative Technologies
- Water Conservation and Reuse
- Land Treatment
- Cost-Effectiveness Analysis
- Environmental Assessment
- Financial Management
- Multiple Use
- Industrial Pretreatment
- Wastewater Facilities Operation and Management
- Urban Stormwater Runoff
- Nonpoint Source Pollution. Agriculture, Forestry and Mining
- Groundwater Contamination

The material in each chapter is not designed to make technical experts out of the readers However, the chapters do contain essential facts, questions to consider, advice on how to deal with issues, and clearly-written technical background material. In short, each chapter provides information that will help advisory group members and local officials to better fulfill their roles

Each chapter contains material addressed specifically to advisory group members; this information is printed in boldface type. There are often boxed-in sections of material containing examples, lists of advantages and disadvantages, questions addressed to local community needs, and other useful information. Two sections of material common to all chapters are case studies which are found on pages tinted gray and a "Need More Information?" section containing annotated resource materials with information on how to obtain them. In addition, a glossary of terms is provided at the end of each volume.

If you would like more information about the program, copies of handbooks, instructor materials, or audiovisual aids, contact the EPA Information Dissemination Project for price lists and rental information:

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Glossary

a

Absorption Field (Bed)—type of absorption system which uses a wide trench partially filled with gravel or crushed stone and covered with soil. Piping distributes treated sewage evenly throughout the bed for seepage into the ground

Account Sheet—a table for displaying impact assessment data to facilitate the comparison of alternatives

Acid Mine Drainage—water with an acidic pH which drains from working or abandoned mines

Activated Sludge—waste solids that have been aerated and subjected to bacterial action process for removing organic matter in raw sewage during secondary waste treatment

Adsorption—attraction and accumulation of one substance on the surface of another

Ad Valorem Tax—a tax imposed at a percent of the assessed property value

Advanced Waste Treatment—treatment processes that can increase waste removal beyond the secondary or biological stage. It includes removal of nutrients such as phosphorous and nitrogen and most suspended solids

Aeration—circulation of oxygen through a substance; aids in purification

Aeration Tank—tank in which oxygen is circulated through wastewater as an aid in purification

Aerobic Digestion—breakdown of organic material by bacteria in the presence of oxygen

Aerobic Treatment—treatment of wastewater using organisms which are dependent on the presence of oxygen to break down organic matter

Aeroclarifier—settling tank utilizing the circulation of oxygen through the wastewater to aid in purification and sedimentation

Alkaline—wastewater with a pH above 7.0; contains relatively few hydrogen ions as compared to an acid

Alternative Wastewater Treatment Systems—various non-conventional methods of central or community wastewater treatment, sludge treatment, energy recovery, and onsite systems that can save energy or cost as compared to conventional treatment systems; they are eligible for an additional 10 percent federal funding over conventional systems

Ammonia Stripping—process in which gaseous ammonia is removed from water by agitating a water gas mixture in the presence of air

Amortize—payment of loans with interest over a period of time

Anaerobic Digestion—breakdown of organic material by bacteria in the absence of oxygen

Aquaculture—growth of plants and animals in water instead of soil

Aquifer—underground bed or layer of earth, gravel, or porous stone that serves as a reservoir for groundwater

Aquifer Recharge—adding water to an aquifer either by spreading on the ground surface or direct injection through wells

Artesian—water confined under pressure between impermeable layers such as clay or shale

b

Best Management Practice (BMP)—technique which deals most effectively with a given problem

Biochemical Oxygen Demand (BOD)—amount of dissolved oxygen required by bacteria to decompose organic matter in water; measure used to indicate the amount of organic wastes in water

Biodegradable—capable of being decomposed through the action of microorganisms

Biodisc—a large rotating plastic disc which provides a surface area for the attachment and growth of microorganisms

Biological Contactor—a series of closely spaced biodiscs that provide a large surface area for the biological removal of organic pollutants from wastewater

Boundary—geographical area or the degree of study

Buffer Strip (Zone)—area of land which acts as a health and safety barrier between a treatment site and the public

c

Carcinogen—cancer-causing substance

Catch Basin—basin located at the point where a street gutter discharges into a sewer; catches and retains matter that would not pass readily through the sewer

Categorical Standards—effluent standards established for a particular industrial category

Centrifugation—the separation of sludge particles from the liquid by a rapidly rotating drum

Chemical Oxygen Demand—measure of the equivalent amount of oxygen required to break down organic and inorganic compounds in water

Chemical Precipitation—treatment technique that utilizes chemicals known as coagulants to cause solids in the wastewater to clump together and settle

Chlorine Contact Chamber—tank in which chlorine is added to treated wastewater for the purpose of disinfection

Clarifier—settling tank where solids are removed from wastewater

Cluster System—community form of onsite disposal in which effluent from several individual septic tanks is transported to a central location for disposal

Coagulation—addition of chemicals such as lime or alum to clump together solids in wastewater so that they settle out faster

Coliform Bacteria—bacteria found in the intestinal tracts of humans and other animals; indicator of fecal pollution

Collection Line or Collector Sewer—sewers including laterals, submains, and mains

Combined Sewer—drainage system that carries both sewage and stormwater runoff

Comminutor—device that catches and shreds large objects in the raw wastewater entering a sewage treatment plant

Composting—natural biological breakdown of organic material in the presence of air; a humus-like material is the end product

Computer Modeling—the programming of a computer to use related input data for analyses or problem solving; such programs can predict events such as stormwater runoff and pollution loading

Conditioning—treatment of sludge with chemicals or heat so that the water may be readily separated

Connection Charge—the one time fee charged to property owners for the privilege of connecting to a central sewer system

Consultation—an exchange of views between governmental agencies and interested or affected persons or organizations; involves communication techniques such as advisory groups and public hearings

Contamination—presence of undesirable substances of biological, inorganic, or organic composition

Cost-Effectiveness Analysis—determination of whether a project or technique is worth funding, both monetary and nonmonetary factors are involved

Criteria—guidelines for making decisions

d

Decreasing Block Rate Structure—cost of water to consumer increases as consumption increases, but at a decreasing rate

Deep-Well Injection—pumping high quality treated wastewater into the groundwater table

Delphi Survey—panel of experts independently moving towards consensus through responses to rounds of questions

Demography—statistical study of populations

Denitrification—anaerobic biological conversion of nitrates into nitrogen gas

Depreciation Costs—those costs associated with the loss of value for capital investments over a period of time due primarily to aging

Detention Basin—small basin for collecting stormwater runoff until the particulates picked up by rain water have settled

Dewatering—separation of water from sludge by vacuum pressure or drying processes

Digester—closed tank where wastewater sludge is broken down by intense bacterial action

Direct Discharge—discharge of an industrial waste other than to a publicly-owned treatment works

Disinfectant—chemical such as chlorine that is added to the wastewater to kill bacteria

Dissolved Solids—total amount of extremely small organic and inorganic material contained in water material capable of passing through a filter paper

Dosing Tank—receptacle in septic systems for providing large flow rates for a short time, rather than a trickle all the time. A dosing tank fills to a certain level and then flushes by siphon action

e

Easement—a right of way granting the use of land for a certain period of time

Ecology—study of relationships between organisms and their surroundings

Ecosystem—the interaction of organisms with their environment

Effluent—treated or untreated wastewater discharged into the environment

Electrodialysis—process by which electricity and a membrane separate mineral salts from sewage

Environment—surroundings including all living and non living factors

Environmental Assessment—a document prepared by the EPA on its assessment of the impact of proposed projects

Environmental Impact Statement (EIS)—detailed analysis of potential environmental impacts of a proposed project. It is required when the EPA determines that a project may have significant adverse environmental effect or is highly controversial

Environmental Information Document—report done by the grantee describing the environmental effects of proposed wastewater projects

Environmental Review—the process by which the EPA identifies and evaluates impacts upon the environment

Erosion—the wearing away of land surface by wind or water

Eutrophication—nutrient enrichment of a body of water producing excessive growths of aquatic plants that deteriorate the water environment

Evapotranspiration Systems—systems which depend on evaporation and transpiration (loss of water from plants) for wastewater disposal

f

Facility (201) Planning—planning local wastewater collection, treatment, and disposal facilities; the number refers to section of the Clean Water Act

Filtration—process of passing wastewater through a granular bed or fine screen for removing suspended matter that cannot be removed by sedimentation

Financial Management—the planning and administrative process by which financial resources are used in their most effective manner

Five-Year Frequency Storm—storm of a certain degree of severity that is expected to occur on an average of every five years

Flat Rate Structure—unit price of water is constant no matter how much is consumed

Floodplain—a nearly flat plain along the course of a stream that is naturally subject to flooding at high water

Force Main—sewer pipe under pressure from a pump to maintain the flow of sewage, used where gravity flow is not feasible

g

General Obligation Bond—financial bond which is usually paid for by the community by raising taxes

Gravity Sewer—collection system which relies on gravity to transport wastewater from homes to a central treatment or disposal facility

Greenway—another name for "buffer zone"

Greywater—bathing, washing, and kitchen wastewater which is no longer potable, but can be filtered and used for other purposes

Grit Chamber—a tank where sand, cinders and small stones are removed from wastewater by settling

Grit Removal—a stage of primary treatment during which sand, cinders and small stones are removed from wastewater by settling out

Groundwater—water lying below the surface of the earth

h

Hardness—property of water that tends to cause scaling and inefficient use of soap, generally caused by the mineral calcium and magnesium

Heavy Metals—metallic elements such as mercury, chromium, cadmium, arsenic and lead with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain

Holding Tank—tank used for storing wastewater prior to treatment; usually used as an alternative for onsite problem areas

Horticulture—science of growing flowers, fruits, and vegetables

House Connection—sewer that carries wastewater from the house to a collection system

Hydraulic Overload—situation when a wastewater treatment plant is unable to handle the large flow of water entering it

Hydrologic Cycle—the flow of water through the air, land, and liquid environments

Hydrology—the science dealing with the properties, laws, and geographical distribution of water

i

Impact Mitigation—the lessening of the effects of a project on the environment

Implementation Cost—the cost to the community resulting from the use of selected mitigation measures

Incompatible Waste—a waste that will 1) upset a treatment works, 2) pass through a treatment works and cause a pollution problem, 3) be removed in the treatment works, but interfere with the disposal of the sludge from the treatment works

Increasing Block Rate Structure—cost of water to consumer increases as consumption increases, and at an increasing rate; also known as a penalty structure

Industrial Closed Loop—the treatment and reuse of waters used in production within an industrial plant so that no water leaves the plant

Industrial Pretreatment—treatment of industrial wastes before discharge to a municipal sewer system

Industrial Waste Ordinance—a common instrument of legal authority for enforcing pretreatment programs

Inequities—injustices or unfairnesses

Infiltration—seepage of effluent through the ground to the water table, or groundwater leaking into cracked or broken sewers

Infiltration and Inflow (I/I)—leakage of ground and surface water into sewers

Infiltration-Percolation Land Treatment—the application of treated wastewater onto land to allow it to percolate downward through the soil in order to remove nutrients such as phosphorous and nitrogen

Inflow—surface water that gets into the sewer system from storm drains, downspouts, and sump pumps often during periods of rainfall

Influent—the raw wastewater entering a sewage treatment plant or in more general terms the flow entering some process unit

Innovative and Alternative Treatment—a nonconventional cost or energy-saving system for treating wastewater, it may qualify for an increase in the federal grant share by 10 percent, from 75 to 85 percent.

Innovative Waste Treatment Systems—systems that, through new ideas and techniques, significantly reduce costs or use of energy, improve control of toxic materials, improve operational reliability, or result in some other public benefit

Inorganic—substances such as metals or minerals that do not contain carbon

Insoluble—material that cannot be dissolved in a liquid

Interceptor Sewer—central sewer pipe which carries flows from the collector sewers in a drainage basin to the point of treatment or disposal of the wastewater

Intrusion Barrier—practice such as injecting groundwater with effluent in coastal areas to force back-intruding salt water

Ion Exchange—exchange of one ion in water for another, specifically, exchanging ammonium nitrogen for sodium or calcium

Irrigation—application of water to vegetation to improve its production

j k l

Joint Treatment—treatment of both municipal and industrial wastes in a publicly-owned treatment works

Lagoon—a pond containing wastewater in which organic wastes are removed under aerobic or anaerobic conditions

Land Reclamation—the reclaiming and reuse of wasteland, swamps, marshes, and other unused or wasted land for useful purposes, such as cultivation or recreation

Land Treatment—process of applying wastewater to the land for removal of pollutants, sludge (the solids removed from wastewater) also may be disposed on land, but it is not called land treatment

Lateral—the small sewer serving individual streets

Leachate—water flowing from the bottom or sides of dumps or landfills that contains material dissolved from the materials stored in the dump

Leaching—process by which substances are dissolved and carried away by water, or are moved into a lower layer of soil

Legal Authority—statutes, ordinances, contracts, or agreements through which a municipality enforces its pretreatment program

Liaison—a go-between to ensure concerted action between parties

Life-Line Rate Structure—schedule providing a minimum basic amount of water at a small cost to all people

Limiting Zone—ground components such as impervious clay, rock, or the water table, which can render an area unsuitable for onsite disposal

Linear Park—a park which is located along a route, such as a sewer right of way or a streamside easement

Loading Rate—rate at which pollutants accumulate in soil or surface waters

Local Pretreatment Program—a procedure for regulating the discharge of industrial waste to a publicly-owned treatment works

m

Main—the intermediate-sized sewers connecting submains to plants or interceptor

Metabolism—process by which food is built up into living protoplasm, and protoplasm is broken down into simpler compounds with the exchange of energy

Methane—a gaseous by-product of the breakdown of organic matter in aerobic digestion

Mitigation Measure—technique for correcting or minimizing adverse environmental impacts

Mitigative Costs—the costs resulting from measures taken to lessen the impacts of a project on the environment

Monetary Costs—costs which can be measured in real dollars.

Mound—a type of onsite disposal system utilizing an absorption field built on a bed of sand

Mound System—a type of onsite disposal utilizing an absorption bed of sand that is above the natural grade of the soil surface

Multiple Use—utilization of wastewater treatment facilities for other functions in addition to wastewater treatment, such as for recreational and educational purposes

n

Nitrification—conversion of nitrogen-containing substances such as proteins into nitrates by bacteria

Nitrogenous—containing the element nitrogen

Notification—information flow from the governmental agencies to interested or affected parties, involves communication techniques such as fact sheets, newsletters, and seminars

Nonpoint Source—a contributing factor to water pollution that can't be traced to a specific spot, such as agricultural fertilizer runoff or construction sediment

Nonstructural Management Alternatives—nonphysical approaches to pollution control such as land use controls such as zoning ordinances, improved urban maintenance programs, and construction activity schedules Often more effective and less costly than structural alternatives

NPDES Permit—permit for discharge of a municipal or industrial waste issued by the EPA or state regulatory agency

o

Onsite Disposal—disposal of wastewater on an individual lot, usually by a septic tank

Onsite Recycle—filtered and/or chemically-treated water which flows from a holding tank back to the toilet for subsequent reuse

Onsite System—a self-contained system which provides both treatment and disposal of wastewater on an individual lot

Opportunity Costs—monetary value of potential benefits lost as a result of a water quality action

Organic Matter—carbon-containing substance

Organic Waste Discharge—waste normally containing oxygen-demanding carbon compounds

Overland Flow—land application technique in which wastewater is sprayed onto gently sloping ground planted with vegetation

Oxidation Pond—a natural or man-made pond where wastewater is processed through the interaction of sunlight, wind, aquatic organisms, and oxygen

p q

Pathogen—disease-causing organism

Pathogenic—disease-causing

PCBs—polychlorinated biphenyls, a group of extremely persistent chemicals used in electrical transformers and capacitors

Peak Demand Rate Structure—increases price of water at high consumption periods, effect of leveling out water usage

Per Capita Daily Consumption—amount consumed per person per day

Percolation—downward flow or filtering of water through pores or spaces in rock or soil

Percolation Test—test for measuring the ability of soil to permit downward flow or permeability of water

Permeability—the degree to which a substance is capable of being penetrated by water

Permeable—quality of an aquifer that permits water to move through it

pH—hydrogen ion concentration in a solution

Point Source Pollution—pollution that is discharged from a single location such as a pipe

Pollutant Loading—amount of pollution contributed by a given pollution source over a time period

Polychlorinated Biphenyls (PCBs)—a group of toxic, persistent chemicals used in making transformers and capacitors

Polymer—chemical compound consisting of repeating structural units

Ponding (Parking Lot, Rooftop)—occurs when a structure is designed so that rain water will collect within its boundaries and will exist at a specific location at a controlled flowrate, rather than running off uncontrolled

Porosity—open spaces or cracks in rock that might fill with water

Precipitation—process where chemicals combine to produce a compound that can be easily removed from a solution

Present Worth—the sum of money that must be placed on deposit at a given interest rate when the project construction begins to provide funds for the anticipated expenditures

Pressure Sewer—collection system in which wastewater is pumped under pressure from homes into a central treatment or disposal facility

Pretreatment—treatment of an industrial waste before discharge to a municipal sewer system

Pretreatment Effluent Standards—concentrations or amounts of toxic chemicals that may be discharged to publicly-owned treatment works

Primary Clarifier—sedimentation tank used for removing settleable solids during primary treatment

Primary Impact—an effect directly related to a program or a project such as noise associated with the construction of a wastewater treatment plant

Primary Waste Treatment—first stage of wastewater treatment, removal of floating debris and solids by screening and sedimentation

Prohibited Wastes—wastes not allowed to be discharged to a publicly-owned treatment works

Public Participation—involvement of citizens in the decision making process

Pump Station—facility located along a sewer to maintain the flow of wastewater under pressure

r

Rapid Infiltration—land application technique in which wastewater is applied to land and is allowed to percolate through the soil and enter the groundwater, thereby treating the wastewater

Responsiveness Summary—document prepared by a planning agency indicating briefly to the public how decision makers have dealt with the actions, comments, and opinions of the public

Retrofit Devices—modifications to be installed on existing equipment

Revenue bond—financial bond which the community pays for through fees for the use of a facility

s

Saline—containing chemical salts, such as sodium, potassium, and magnesium

Salt Water Intrusion—the seepage of saltwater into fresh groundwater, often caused by overpumping the groundwater

Sanitary Sewer—collection system which carries wastewater produced in homes and industry, a separate collection system carries stormwater runoff

Sanitary Wastewater—refers to wastewater produced in homes and industry, and separate from stormwater runoff

Saturated Zone—layer below the water table where all cracks and pores are filled with water

Secondary Clarifier—sedimentation tank used for removal of settleable solids and scum created during secondary treatment

Secondary Impact—effect indirectly caused by a program or project, such as community growth induced by wastewater treatment facilities

Secondary Treatment—microbiological treatment of wastewater to consume organic wastes usually in the presence of oxygen. Floating and settleable solids, and about 85 percent of oxygen demanding substances and suspended solids are removed. Disinfection with chlorine is the final stage of secondary treatment

Sediment Detention Basin—structural facility for temporarily storing stormwater runoff, during which time sediment is removed by settling

Sedimentation—a nonpoint source of pollution caused when construction disturbs the soil and sediment is washed from the construction site and enters urban stormwater; also more generally, the settling out of solids in wastewater or stormwater by gravity

Seepage Bed—type of absorption system which uses a wide trench partially filled with gravel or crushed stone and covered with soil. Piping distributes treated sewage evenly throughout the bed for seepage into the ground

Separate Sewer—collection system which uses a sanitary sewer to carry only wastewater, and a storm sewer to carry runoff from rainwater

Septage—the solids collected in septic tanks over many months of operation

Septage Treatment—treatment of the solids collected in septic tanks over many months of operation

Set Price Rate Structure—each group of customers pays a set amount for any amount of water consumed

Sewer Interceptor—pipe which carries flows from the collector sewers in the drainage basin to the point of treatment or disposal of the wastewater

Sewer Lateral—small sewer pipes in the street to which the individual users connect

Silviculture—a phase of forestry dealing with the establishment, development, and harvesting of trees

Sludge—concentrated solids removed from sewage during wastewater treatment

Sludge Digester—heated tank where wastewater solids can decompose biologically and the odors can be controlled

Soil Profile—a graphic representation of soil components

Soluble—material that can be dissolved in a liquid to form a homogeneous material

Special Assessment Bond—financial bond issued to pay for public improvements where specific and direct benefits exist, payments from parties who benefit retire the bonds

Spray Irrigation—the application of treated effluent onto land by spraying to provide irrigation

Stabilization—digestion of the organic solids in sludge so that they may be handled without causing a nuisance or health hazard

Step One Planning—initial planning stage for water pollution control facilities as administered through the Construction Grants Program.

Step Two Design Grant—the second stage of planning when a water pollution control alternative is designed as administered under the Construction Grants Program

Stream Divergence—altering and/or dividing the flow course of a stream to reduce the effects of high flows on the land surface

Structural Management Alternatives—involve physical entities for delaying, blocking, or trapping pollutants As compared to nonstructural approaches, they are often expensive

Structural Methods—construction of physical entities for delaying, blocking, or trapping pollutants

Submain—sewer connecting laterals to mains

Subsidence Preventive—use of groundwater injection to prevent soil from subsiding or settling excessively

Supernatant—the relatively clear liquid that forms on the top of the digested sludge in the second tank of a two-stage anaerobic digestion process

Surface Water—accumulations of water on top of the ground, such as lakes, streams, and the oceans

Suspended Solids (SS)—tiny pieces of solid pollutants in sewage that cause cloudiness and require special treatment to remove

t

Thickening—separation of as much water as possible from sludge by gravity or flotation techniques

Total Dissolved Solids—the total amount of dissolved organic and inorganic material contained in water

Toxic Chemical—one of a number of deadly substances, it appears on a list published by the EPA

Transpiration—loss of water from plants

Trickling Filter—a secondary treatment process where wastewater seeps through a film of microorganisms growing on stones or a synthetic medium As the wastewater trickles through the media, the microorganisms metabolize most of the organic pollutants

Turbidity—cloudy condition in water due to suspended silt or organic matter

201 Plan—local plan for wastewater treatment facilities under the Construction Grants Program of the EPA, the number refers to a section of the Clean Water Act

201 (Facilities) Planning—deals with the planning, designing, and construction of local wastewater treatment facilities

208 Plan—regional, state or areawide plan for water quality management, the number refers to a section of the Clean Water Act

208 (Water Quality Management) Planning—water quality planning with a state, regional, or areawide scope, provides guidance for individual 201 facility plans

u

Unit Processes—individual functioning parts of a whole system

Unsaturated Zone—soil layers above the water table, where water adheres to soil particles and will not flow to a well

User Charge (Fee)—prices charged to the consumers of various public services

v

Vacuum Filter—a cylindrical drum filter which uses a vacuum to separate the solids from the water

Vacuum Sewer—collection system in which a central vacuum source maintains a vacuum on small-diameter collection mains

w x y & z

Wasteload Allocation—the maximum pollutant load that a facility is legally permitted to discharge to a water body

Water Quality Management (208) Planning—planning for the maintenance of clean water at the state, regional, and areawide levels

Water Quality Standard—levels of pollution parameters or stream conditions that must be maintained to protect desired uses of water

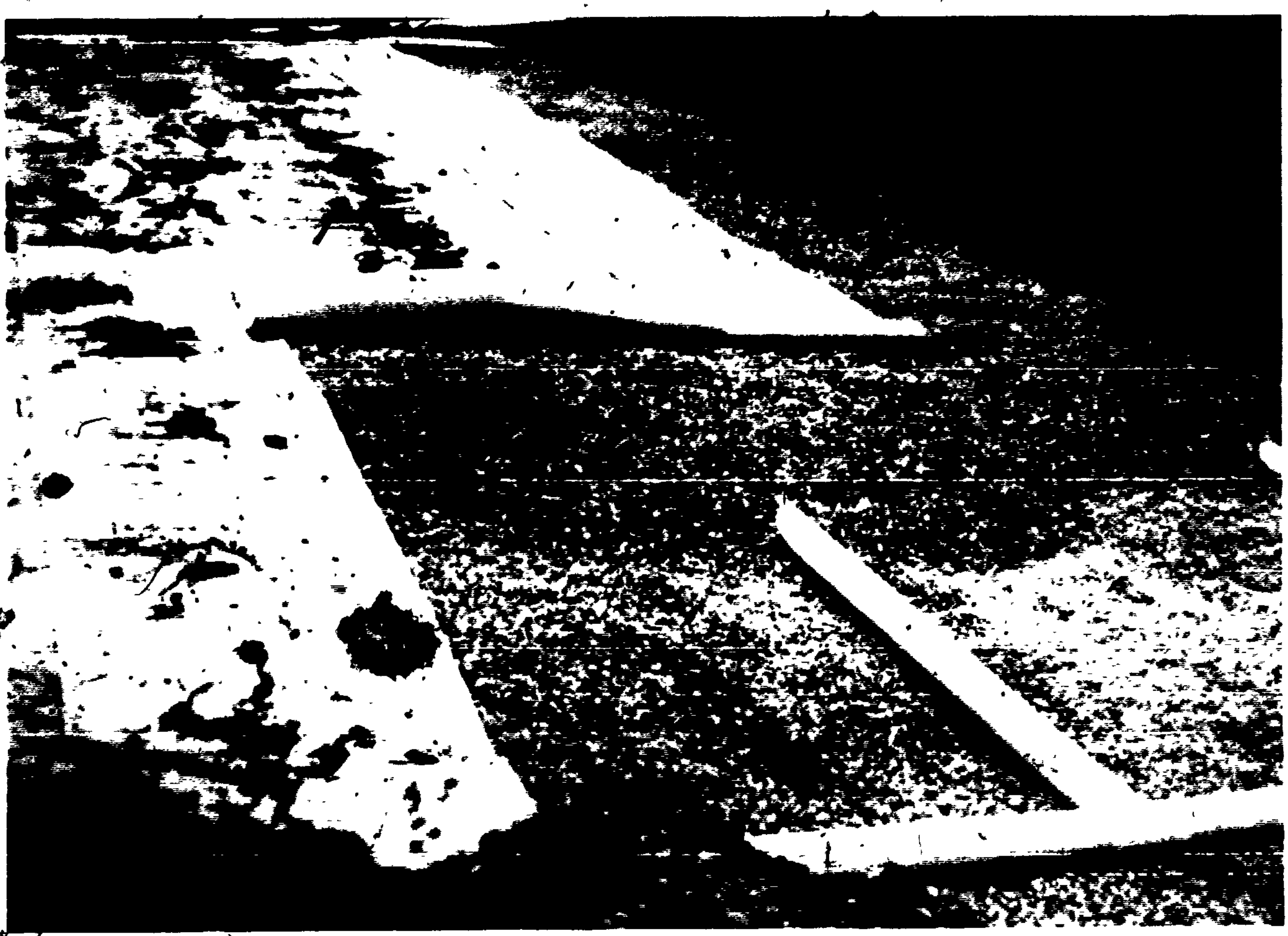
Water Recharge—adding water to an aquifer either by spreading on the ground surface or by direct injection through wells

Watershed—the land area that drains into a stream or river

Water Table—top surface of the groundwater

Wet Air Oxidation—process of breaking down solids in wastewater under conditions of high temperature and pressure

Wetlands—low-lying lands which frequently have standing water on them, such as swamps, marshes, and meadows Wetlands essentially are pollutant traps in natural environments



Chapter 7

Innovative and Alternative Technologies

Charles A. Cole

Great concern has developed in recent years over the enormous cost of many conventional wastewater treatment facilities These concrete and steel facilities are not free gifts from the federal government Local communities soon realize their share of the capital costs has to be paid with interest There are also sizable operation and management costs associated with these plants The concern over rising costs of wastewater treatment led Congress to place new emphasis on "nonconventional" systems in The Clean Water Act of 1977 Some of the keystones of the Act encourage communities to use innovative and alternative technologies to achieve the Nation's water quality goals.

The United States Environmental Protection Agency (EPA) has developed regulations and guidelines for achieving the goals of the Act, while still maintaining the momentum of the Construction Grants Program. In encouraging communities to consider innovative or alternative technologies, *the federal construction grant share has been increased by ten percent from 75 to 85 percent* This increase amounts to a *40 percent reduction* in capital costs that the locality must finance! If an innovative system fails to operate properly, the law provides for 100 percent grant assistance to pay the cost of modifications or replacement.

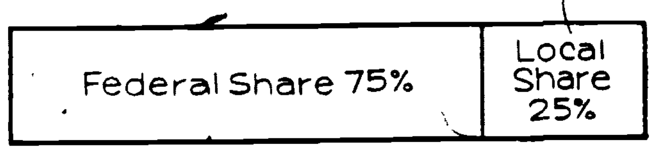
Technology Choices

The Clean Water Act of 1977 requires that all wastewater treatment facility planning consider innovative and alternative technologies. So what are innovative and alternative technologies? Conventional methods of treatment are generally defined as biological or physical-chemical processes used prior to wastewater discharge to surface waters. In various forms, these processes are commonly used in sewage treatment plants

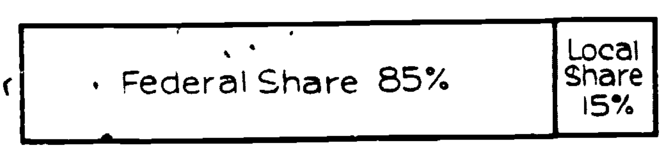
Innovative and alternative technologies, in addition to providing the treatment levels of conventional technologies, also exhibit at least one of these beneficial characteristics

- Provide for the reclamation and reuse of wastewaters
- Conserve or recover energy
- Are economically attractive relative to conventional technologies

The Clean Water Act requires that each state set aside two percent of the construction grant funds it receives from the federal government each year These funds are to be used for innovative and alternative technologies In 1981 this amount increases to three percent At least one fourth of this amount is for innovative options alone The whole project need not meet the innovative or alternative criteria A part of the project may do so and be funded proportionately



Conventional Technology



Innovative and Alternative Technologies

The advisory group should check with the state water pollution control agency to see if this annual set aside is being used.

Alternative Technologies

Alternative technologies include various methods of central or community wastewater treatment, sludge treatment, energy recovery, and onsite systems. They qualify for ten percent additional construction grant funding. The Act emphasizes alternative technologies that recycle or reuse treated wastewater and avoid surface water discharge altogether

The Clean Water Act places major emphasis on land treatment of effluent and sludge. Many areas of the country are already utilizing land disposal. Others such as Lake Tahoe, California, are planning to use it. A potential local cost savings of 44 percent is predicted for the use of land treatment instead of a sophisticated advanced wastewater treatment (AWT) facility in attaining the same level of pollution control. The Lake Tahoe AWT plant was the model for the country a decade or more ago. Now, because of concern over costs and energy use, many communities are beginning to re-think their app ach to wastewater treatment.

Comparisons of 1981 Costs for Facilities

Lake Tahoe, California

Treatment	*Facilities Total Present Worth Million $*	*Average Local Cost $/1000 Gallons*
Precipitation and Ion Exchange (Advanced Waste Treatment)	51	1 58
Flood Irrigation (Land Treatment)	33	0 88
Savings	36%	44%

Innovative Technologies

Alternative systems that are not fully proven may qualify as innovative technologies if they meet *any one* of the following six criteria:

- Improved operational reliability
- Better management of toxic materials
- Increased environmental benefits
- Improved joint treatment of municipal and industrial wastes
- 15% reduction of cost for the life of the system (typically 20 years)
- 20% reduction of net energy consumption.

If an "unproven" alternative technology is designated by EPA as innovative, it becomes eligible for 100 percent grant assistance should the system fail.

An important point to remember is that even a conventional method of treatment can be considered innovative. First, it must be a developed technology that is not fully proven under the circumstances of proposed use. Second, it must meet either of the last two criteria above. a life cycle cost reduction of at least 15 percent, or a net energy reduction of at least 20 percent. Those projects, or portions of projects, meeting the requirements of innovative technology qualify for ten percent additional federal funding

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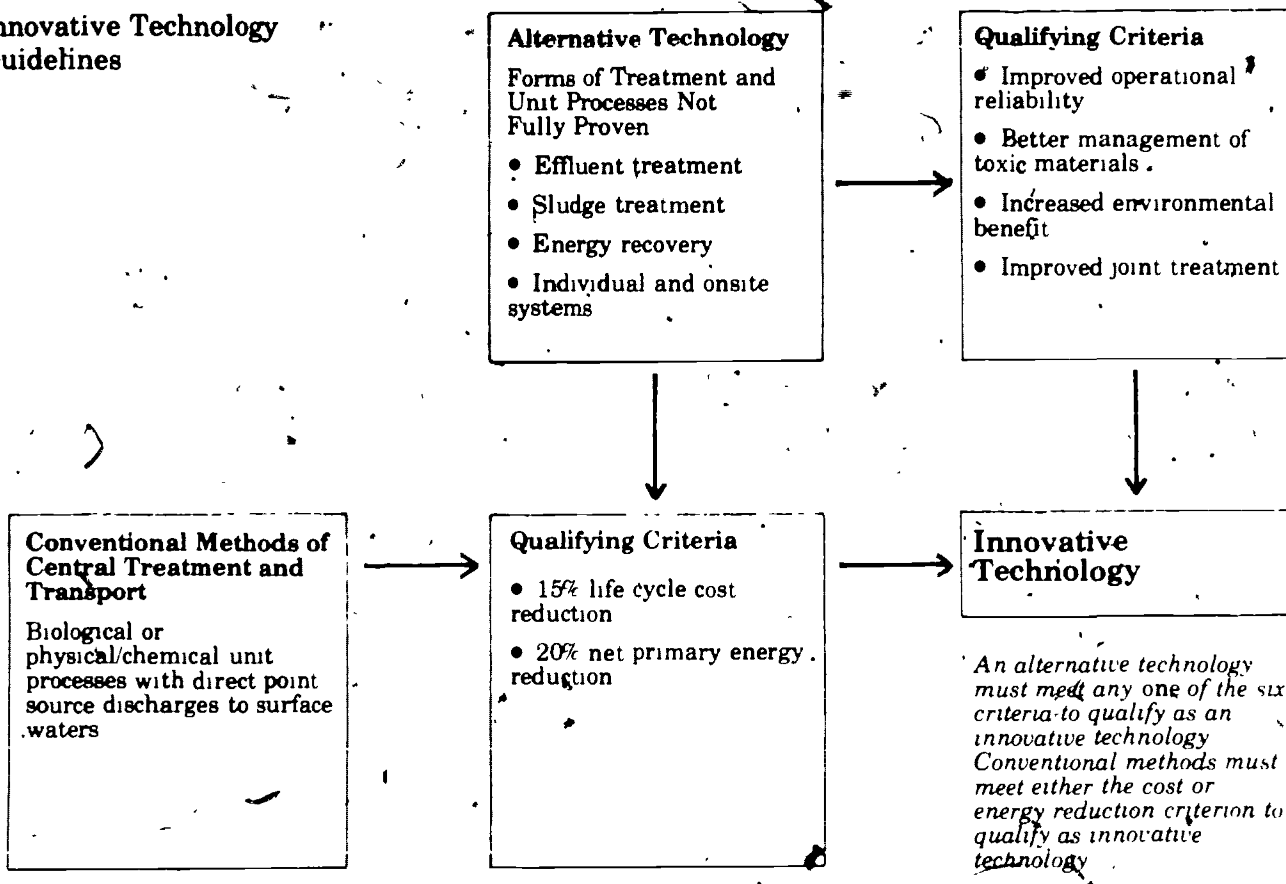
Innovative Technology Guidelines



Selection Process

How does one go about determining innovative or alternative funding eligibility? The study process involves several decision points, including:

- Determination if technology is fully-proven
- Satisfaction of qualifying criteria
- Determination of cost-effectiveness.

The EPA makes the final determination on funding eligibility.

Fully Proven?

First, it is necessary to determine if the alternative technology is developed to the extent that the risk of full-scale use is acceptable. If it is and it also is cost-effective, 85 percent funding is allowed. Conventional technologies that are fully proven are not given the grant incentive reserved for innovative processes

Satisfies Innovative Criteria?

Next, one determines if a not fully-proven conventional or alternative technology meets one of the six qualifying criteria. The whole project need not meet all of the innovative criteria Part of the project may qualify and be funded proportionately

Alternative Technologies

Effluent Treatment	Sludge Treatment	Energy Recovery	Individual, Onsite, and Small Community Systems
land treatment aquifer recharge aquaculture silviculture horticulture revegetation of disturbed land containment ponds treatment and storage prior to land application direct reuse (non-potable water)	land application composting prior to land application drying prior to land application	co-disposal of sludge and refuse anaerobic digestion with methane recovery self-sustaining incineration	onsite treatment cluster treatment septage treatment alternative collection system for small communities

Cost-Effective?

Finally, a cost-effectiveness analysis is performed to determine if alternatives are worth funding The method used is the same as that normally used for facility plans, except that alternative technologies and conventional options that save energy are granted a 15 percent cost preference (This means they could cost up to 1 15 times more than the most cost-effective conventional technology, and still receive the additional ten percent funding) Analyses are done on systems that provide equivalent levels of pollution control

Collection systems for small communities that include pressure sewers, vacuum sewers, or small diameter gravity sewers may also qualify for the increased grant and the 15 percent cost-effectiveness preference.

All considerations, including multiple uses such as recreation and resource recovery, should be included in the analysis

During the screening and evaluation of alternatives, the advisory group can provide a valuable service to the community by:

- **Encouraging the grantee and consultant to consider innovative and alternative technologies**
- **Providing a public forum to discuss potential innovative and alternative solutions for the community**
- **Providing information about local problems and circumstances which can be used in the consideration of innovative and alternative options**
- **Ensuring that innovative and alternative technologies are adequately evaluated for the community**
- **Continuing to look for cost and energy savings through innovative processes; even after the number of alternatives has been narrowed**
- **Building public support for an innovative or alternative facility.**

Operation and management costs, paid for entirely by the local government, are usually less expensive for alternative technologies All too frequently communities have been overburdened with an elaborate system that they can't afford to operate Once the grantee is aware of the monetary benefits of the innovative and alternative technologies, various options can be recommended for evaluation.

Members of the advisory group are familiar with the local situation Knowledge concerning the appropriateness of various technologies for local conditions will be helpful to the grantee as well as the consultant.

If it appears that conventional technologies are best for wastewater treatment, the advisory group should still watch for innovation Projected energy and cost savings may meet the innovative funding criteria, and then qualify the project for

the additional ten percent funding. The advisory group should also be sure that onsite systems are given careful consideration as treatment options. If they are constructed and maintained as a community project, these onsite systems also qualify for additional funding.

Two keys to successful advisory group participation are:

- **The advisory group can take the lead in encouraging the consideration of innovative and alternative technologies for the community**
- **The advisory group should monitor the analysis of innovative and alternative technologies and be satisfied that the evaluation is thorough and accurate.**

These are often difficult tasks. To be effective the advisory group must work closely and cooperatively with the grantee and consultant. In some cases technical advice and support may be sought from the state water pollution control agency and the EPA Regional Office.

Other Considerations for Small or Dispersed Communities

Besides encouraging innovative and alternative technologies for point discharges. The Clean Water Act of 1977 has extended the Construction Grant Program to include individual and small community systems. In fact, four percent of the construction funds allocated to rural states are set aside exclusively for funding "alternatives to conventional treatment works" in communities having populations under 3,500 persons, and in highly-dispersed sections of large communities. The four percent set aside applies to states with rural population of 25 percent or more or for a non-rural state at the request of the Governor

Individual systems are defined as privately-owned alternative wastewater treatment works serving one or more principal residences or commercial establishments which are not part of any conventional treatment works Individual systems are eligible for 85 percent funding. Commonly used technologies for onsite systems include

- Septic tanks
- Aerobic tanks
- Absorption beds
- Sand filtration-disinfection processes
- Mound systems
- Evaporation and/or transpiration systems
- Waterless toilets and greywater systems
- Onsite recycle systems

An onsite disposal system without adequate provisions for treating septic tank solids, called septage, may be an unsatisfactory substitute for a conventional system The guidelines, therefore, identify septage treatment as an alternative technology qualifying for an 85 percent grant

In order for onsite and small community systems to be eligible for federal funds, a public body must apply for the funds and guarantee that the systems will be adequately managed and maintained Specific operation and management procedures must be included in the final facility plan

Construction of a small system

What Happens if the Innovative or Alternative System Fails?

If any innovative or alternative facility fails to reach its design performance within two years of operation, the EPA is authorized to make a grant funding 100 percent of the cost of modifications or replacement Only negligence on the part of the design firm will prevent the refunding of projects on the state priority list

Innovative Criteria

As stated earlier, alternative technologies that are *not fully-proven* may qualify for 85 percent federal funding as innovative projects if they meet any one of six criteria:

- 15 percent reduction of life cycle cost
- 20 percent reduction of net energy consumption
- improved operational reliability
- better management of toxic materials
- increased environmental benefits, OR
- improved joint treatment of municipal and industrial wastes

The intent of these criteria is to encourage the use of technologies, such as land application or reuse and reclamation systems. The cost and energy criteria establish specific performance levels. The remaining four are not as specific and, therefore, need further explanation.

Improved Operational Reliability

Alternative technology contributing towards improved operational reliability must meet one of the following conditions to qualify as being innovative:

- Decreased susceptibility to upsets
- Reduced occurence of effluents that fail to meet quality criteria
- Decreased levels of required operator attention and skills

The innovative technologies may include the use of unique operational procedures, land application schedules, and special materials, equipment, or processes.

Improved Management of Toxic Materials

Since many human health problems are attributed to toxic chemicals, technology for reducing direct or indirect exposure to these materials is highly encouraged. These toxic materials also often have an adverse effect on the operation of conventional sewage treatment plants. The primary source of toxic compounds in wastewater is industrial discharges to the municipal system. Toxic materials leave the sewage treatment plant primarily in the sludge, but some may be discharged in the effluent or escape into the air. These toxic chemicals may be reduced or controlled by:

- Isolation of the toxic agent
- Changing the chemical structure to make it nontoxic
- Destruction by such methods as burning or biological breakdown

Increased Environmental Benefits

Increased environmental benefits are probably the most difficult of any of these four criteria to define. Such benefits include the use of nutrients from sludge or effluent for growing crops or fish; land reclamation such as the recovery of mine spoils, the recharge of groundwater aquifers.

The monetary benefit of alternative technologies is illustrated by the land treatment system of Muskegon, Michigan. The revenues of crops irrigated by effluent reduced operation and management costs by 59 percent during 1978.

Comparison of Operations and Management Costs

Muskegon and Warren, Michigan

Item	*Slow Rate Land Treatment Muskegon*	*Advanced Waste Treatment Warren*
Flow, mgd	28	30
Cost, ¢/1000 Gallon	7 1¢*	24 6¢
Per capita cost, $/yr	$4 50	$16 00

**Reduced from 16 9¢ as a result of crop revenues - a drop of 59 percent in 1978*

Improved Joint Treatment of Municipal and Industrial Wastes

Improved joint treatment refers to (a) treatment of industrial wastes discharged into a municipal wastewater collection system, and (b) the joint treatment and disposal of municipal and industrial sludges. The facility plans qualifying for innovative technology must meet EPA's general pretreatment regulations. Joint treatment may be improved by using industrial waste or waste products to provide better municipal collection, treatment, or sludge disposal, or by using municipal sludge to enhance industrial waste processing. An example is the use of chemical solutions from a steel mill to help thicken municipal sewage

Old Ideas, New Ideas

What we are calling innovative is not necessarily new It can be the recycling of old ideas In advocating new or revived engineering and design practices, Congress and the EPA have shown a willingness to accept a greater degree of risk in order to achieve advancement in the state-of-the-art

The regional EPA administrator can designate a project as *innovative* if he/she feels that significant environmental or public benefits can result

Innovative systems may be processes, concepts, or equipment. The innovative designs may include

- Greater integration and use of natural processes
- Maximum use of available physical surroundings
- Invention or development of new equipment and processes
- Modification, adaptation, or improvement of fundamental biological, chemical, or physical processes
- Improved efficiency or control of known processes
- Application of processes or equipment originally developed for another purpose to the treatment of municipal wastewater
- Unique combinations of processes and techniques that create new treatment alternatives

Reuse, Reclamation, and Energy Recovery Opportunities

Effluent Reuse

- Irrigation for nutrients or water
- Commercial and industrial recycle for nutrients, water, or heat
- Aquacultural uses including all production and processing operations
- Groundwater injection as supplemental water source, intrusion barrier, or subsidence preventive

Beneficial Sludge Use

- Land spreading of municipal sludges
- Joint treatment, blending, and disposal of municipal sludges, solid wastes, and industrial sludges
- Use of municipal sludges as new materials for industrial or commercial production of saleable products

Energy Conservation, Reclamation, and Recycle

- Solar energy to accelerate temperature-sensitive processes and space heating in wastewater treatment operations
- Use of heat pumps to extract heat from effluents
- Digester gas for in-plant or off-plant uses, including sale for industrial or commercial activities
- Gas recovery from landfill operations
- Accelerated vegetation growth and harvesting
- Waste heat recovery and reuse for thermal and combustion processes

Industrial and Commercial Reuse or Reclamation

- Industrial use of waste heat from municipal treatment systems
- Municipal use of waste industrial heat
- Commercial use of wastewater effluents
- Industrial use of wastewater
- Joint industrial municipal disposal of effluents or waste solids
- Use of industrial waste products for beneficial municipal uses
- Use of municipal waste products for beneficial industrial uses

Multiple Uses and Recreation

Innovative planning of wastewater systems does not end with the treatment of wastes, the recovery of resources, or the disposal of residues. Additional multiple uses of wastewater treatment facilities should be considered, especially in recreation and open space For example, sewer line rights-of-way connect disjointed park systems, and become recreational paths for cycling, hiking, horseback riding, snowmobiling and cross-country skiing On the West Coast a support for an outfall pipe serves as a fishing pier. Even abandoned wastewater plants have recreational uses. In Ohio an old clarifier is now a splash pool and roller-skating area

Wastewater facilities should be considered as community resources with many functions

As part of its overall role in facility planning, the advisory group should initiate and pursue this type of thinking, and stimulate interest throughout the community.

What Can We Conclude?

A recycling of some good old ideas, an adoption of some good new ideas, and some innovation may save the community money (both in capital expenditures and operation and management expenses) and lower energy consumption. An innovative or alternative system can receive an additional ten percent federal funding if it qualifies If an innovative facility fails to operate properly, federal law provides 100 percent grant assistance to pay for the cost of correction.

The facility planning process provides an excellent opportunity for a community to develop a wastewater treatment system that it can live with and afford.

The advisory group is in a key position to see that this happens. Before a final plan is selected, the advisory group should ask itself a very important question: Are we convinced that *all* the alternatives have been adequately evaluated?

Crop irrigation

Alternative Treatment: A Low Pressure Sewer System with Aerated Lagoons

Quaker Lake, Pennsylvania

Adapted from Milnes, T R and N Smith, "Community Action at Quaker Lake A Low Pressure Sewer System with Aerated Lagoons," Water Pollution Control Association of Pennsylvania Magazine, Volume XI, Number 6, November-December 1978, pp 6-10

Quaker Lake, in northeastern Pennsylvania, has experienced water pollution problems which typically accompany population build-up around lake shores Quaker Lake is surrounded primarily by summer cottages. Of the 110 total residences approximately one-quarter are occupied year-round

Significant pollution of Quaker Lake occurred as the soil around the lake could not absorb the increasing household wastes As a result of the malfunctioning septic systems, the lake received nutrient-rich groundwater seeping from the surrounding residences The groundwater flows accelerated the excessive vegetative growth and deposits of eutrophication

Background

The movement to save the lake began in 1971, after improvements were completed on an antiquated water supply system serving about one-third of the lake's residences. As a result of increased water supply, some septic systems were unable to handle the greater household wasteload, sometimes turning yards into smelly mires

At the request of a resident, the Cottage Owners Association inquired into the feasibility of installing a sewer system around the lake. The initial study by an engineering firm proposed a conventional treatment plant and a gravity sewer system surrounding the lake. The residents realized this project would be tremendously disruptive and very expensive.

As a result of the initial study, a great deal of interest in the water quality of the lake was generated. The Quaker Lake Environmental Study Group was formed to further study the community's environmental problems. Through their efforts the community became aware of the lake's increasing deterioration. Well-attended meetings featured discussions on biology, soils, fish and sewage disposal alternatives.

The Environmental Study Group evolved into the Property Owners of Quaker Lake, who arranged for a new feasibility study by another engineering firm. The new study, completed in 1972, recommended an alternative consisting of a low pressure sewage collection network around the lake with a lagoon wastewater treatment system A decision was made by the Property Owners to go ahead with the recommended system The Silver Lake Township Sewer Authority was appointed by the Township Board of Advisors to implement the plan

Financing

The search for funding was tedious and discouraging The Pennsylvania Department of Environmental Resources would not release any funds because Quaker Lake was not considered a priority project. Agreement was eventually reached with the Farmers Home Administration (FmHA) for a $143,000 grant (36 percent of the cost) and a five percent 40-year loan for $226,500 (56 percent of the cost) The local share of $30,000 (8 percent of the cost) was met through sewer revenue bonds sold to community residents

As a prerequisite to securing the FmHA loan and grant, the Sewer Authority had to obtain easements from every property owner who would have sewer mains through their land. The easements granted permission in perpetuity for the installation, management, and repairs of the lines.

Careful planning by the Authority led to an early retirement of the $30,000 bond issue, thus saving considerable interest costs. The hookup fee, at $350 per residence, generated sufficient funds to retire the bond issue in only one year of a three-year term.

Implementation

In spring of 1976 construction of the sewer project began. After expecting a summer of inconvenience and disruption, most residents were hardly aware that installation was going on.

The construction consisted of sewer mains of two, three, and four-inch plastic pipe installed around the lake, with a six-inch interceptor leading to the treatment lagoons The pipes were installed at depths of only 54 inches. This design contrasts sharply with a conventional gravity flow sewer system that typically requires depths of many feet. In an emergency, any section of the system can be bypassed through a hose owned by the Authority

Grinder pumps were purchased by the Authority to be installed at each residence at the owner's expense The grinder pumps are self-contained units, installed so that household wastes flow into a wet well Sewage is automatically pumped through the grinder to the main collection line which leads to a lagoon

The aerated earthen lagoon system is located outside the lake's drainage area. The lagoons provide a natural, non-chemical treatment which gives off no odor, leaves no sludge, and requires little maintenance. Sand filtration and chlorination as final treatment are required by the Pennsylvania Department of Environmental Resources for discharge into the adjacent Little Rhiney Creek.

The pressure sewer system consisting of grinder pumps and pressure pipes has performed well Initially, several service calls were required to make adjustments or replacement of such items as alarms or controls. In three instances, the central pumping unit was replaced, all under the manufacturer's warranty

The sewage treatment system has proved easy to operate during winter and summer Overall performance has been consistently good The facilities have no odor or sludge problems

Significance

The residents of Quaker Lake, through their unusual curiosity and determination, came to understand the true condition of the lake and eventually reached their goal of halting its further degradation Their awareness of problems associated with conventional treatment and sewer systems around lake shores led them to investigate and ultimately implement an alternative type of wastewater management system.

Quaker Lake

Projects Using Innovative and Alternative Technologies

These project summary descriptions are based on information contained in the Innovative and Alternative Clearinghouse forms submitted by the EPA regional coordinators

Alabama
Dry Creek Wastewater Treatment Plant

Total Grant $25,865,000
Alternative Grant Portion $5,948,950

Alternative Components Anaerobic digesters, sludge thickeners, gas sphere

Process Description Additions were made to the Dry Creek Wastewater Treatment Plant to add secondary treatment and increase flow to 24 mgd. Alternative processes included a digester, thickeners, gas sphere, blower building and standby generators for energy recovery, and aeration equipment and computer for energy conservation.

Florida
Leesburg Wastewater Treatment Plant

Total Grant. $8,415,967
Alternative Grant Portion $459,510

Alternative Components Storage lagoon, effluent pump station, transmission line, emergency retention pond, spray irrigation system, groundwater monitoring system, crop harvesting system

Process Description The treatment mode is conventional activated sludge with fixed mechanical aeration and disinfection before spray irrigation. Sludge will be dried on drying beds and hauled by truck to landfill. Purpose of project is to eliminate existing treatment plant effluent discharge into Lake Griffin and provide adequate treatment of wastes to allow low rate land spreading of effluent without endangering water quality

Idaho
City of Burley Sewage Treatment Plant

Total Grant $843,000
Innovative Grant Portion $674,000

Innovative Components Microscreens

Process Description The microscreen is expected to save 28 percent in present worth cost and 25 percent in net primary energy over alternative physical/chemical processes The microscreen will be added to an existing three-cell lagoon for algae removal to meet state secondary treatment requirements.

Maryland
Jonesville/Jerusalem Sewage Facilities

Total Grant $89,400
Alternative Grant Portion $89,400

Alternative Components Aerobic digesters, sludge land spreading system, grinder pumps, pressure sewers

Process Description The process utilizes a batch aerobic pretreatment unit, bermed cell land application system (eliminates surface discharge of pollutants), and sewage grinder pumps and pressure sewers (alternative collection system for small community)

Nebraska
Stapleton Wastewater Treatment Facility

Total Grant: $60,739
Alternative Grant Portion: $60,739

Alternative Components Lift station, force main, total containment lagoon

Process Description Existing mechanical plant is being replaced with a lift station, force main, and complete retention lagoon The complete retention lagoon and associated equipment are being classified as alternative technology

South Dakota
Yankton Wastewater Treatment Plant

Total Grant $3,700,000
Alternative Grant Portion $1,150,700

Alternative Components Sludge processing facilities, digester gas recovery facilities, electrical power generating system using methane, effluent recycle system

Process Description Modifications were made to a secondary treatment plant. Secondary digester gas system utilizes 100% methane recovery The methane is then used to generate electrical power A system was added to direct effluent reuse on the plant site and bulk sales for non-potable purposes Plans for sludge disposal include land application on agricultural land (60%) and sale of composted sludge (40%).

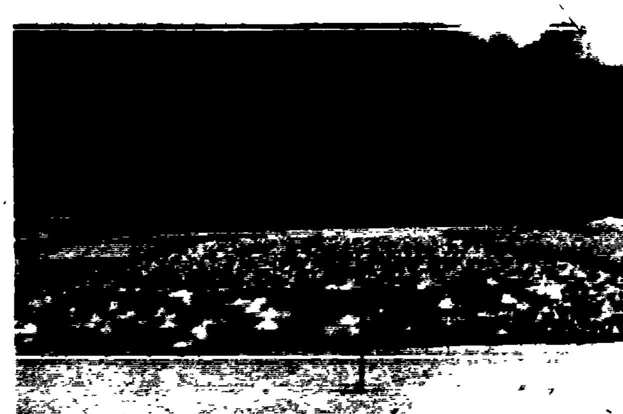
Composting with sludge and wood chips

Washington
Dryden Wastewater Facility

Total Grant $269,700
Alternative Grant Portion $156,426

Alternative Components Septic tanks, drainfields

Process Description Existing community septic tank and drainfield system failed. Project includes construction of new septic tank and drainfield at location where groundwater contamination will not be a problem Interceptor to connect existing system to new facility is not funded as I/A.



Aerated lagoon in the winter

Innovative and Alternative Technology Assessment Manual. MCD-53, Publication Number EPA-430/9-78-009. Washington, DC: U.S. Environmental Protection Agency, 1978. 318 pp.

Need More Information?

This is an excellent reference manual for innovative and alternative technology assessment and cost-effectiveness analysis. The general classification and screening approach is covered as well as a detailed description of the criteria on which innovative and alternative technologies are developed. There are 117 separate fact sheets which describe municipal wastewater processes, including cost and energy data. Fact sheets on onsite disposal alternatives are also included. It is available from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225. Indicate the MCD number and the title of the publication.

Assistance may be provided by the Innovative and Alternative Technology Coordinator in the Water Division of each EPA Region.

Innovative and Alternative Technologies

The procedure to use in determining if a system or part of a system will be eligible for innovative and alternative funding is illustrated in Figures 1 and 2. The facility consultant will need to follow through this assessment process as the system is planned

Figure 1

Referring to Figure 1, the procedure for assessing if the *alternative technology* will be funded as innovative is as follows.

Begin with Point A

At Point A - Determine if the proposed alternative technology has been proven in the circumstances of its intended use.

If YES - Proceed to Point C
If NO - Proceed to Point B

At Point B - Determine if the technology meets any one of the six qualifying criteria for innovative technology.

If YES - Proceed to Point C
If NO - Not funded

At Point C - Determine if the technology cost is within 15 percent of the most cost-effective conventional alternative

If YES - 85 percent funding
If NO - Not funded

Figure 2

Referring to Figure 2, the procedure for determining if *conventional methods of treatment* will be funded as innovative is as follows

Begin at Point A

At Point A - Determine if the proposed technology has been proven in the circumstances of its intended use.

If YES - Proceed to Point D
If NO - Proceed to Point B

At Point B - Determine if the proposed technology meets the 15 percent life-cycle cost reduction.

If YES - 85 percent funding
If NO - Proceed to Point C

At Point C - Determine if the proposed technology meets the 20 percent net primary energy reduction criteria

If YES - Proceed to Point E
If NO - Not funded

At Point D - Determine if the technology is the most cost-effective alternative

If YES - 75 percent funding
If NO - Not funded

At Point E - For technologies that have met the energy criteria, determine if they are within 15 percent of the cost of the most cost-effective alternatives.

If YES - 85 percent funding
If NO - Not funded

Figure 1
Decision-Making Methodology

A Fully proven?

B Satisfies innovative criteria?

C Cost-effective? within 15% of the most cost-effective conventional alternative

Funding

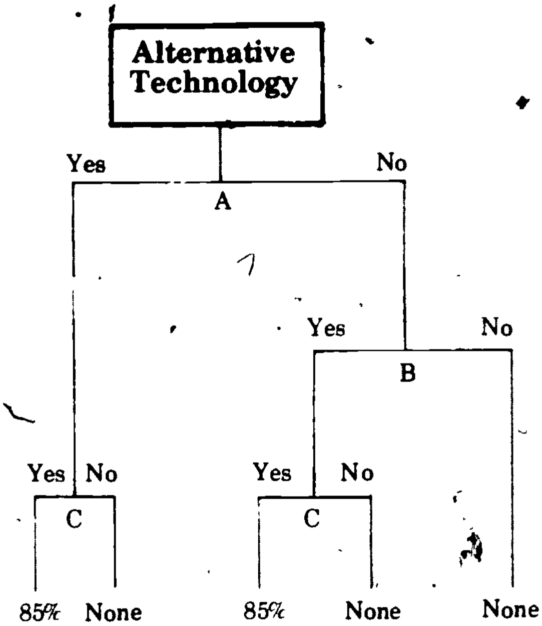


Figure 2
Decision-Making Methodology

A. Fully proven?

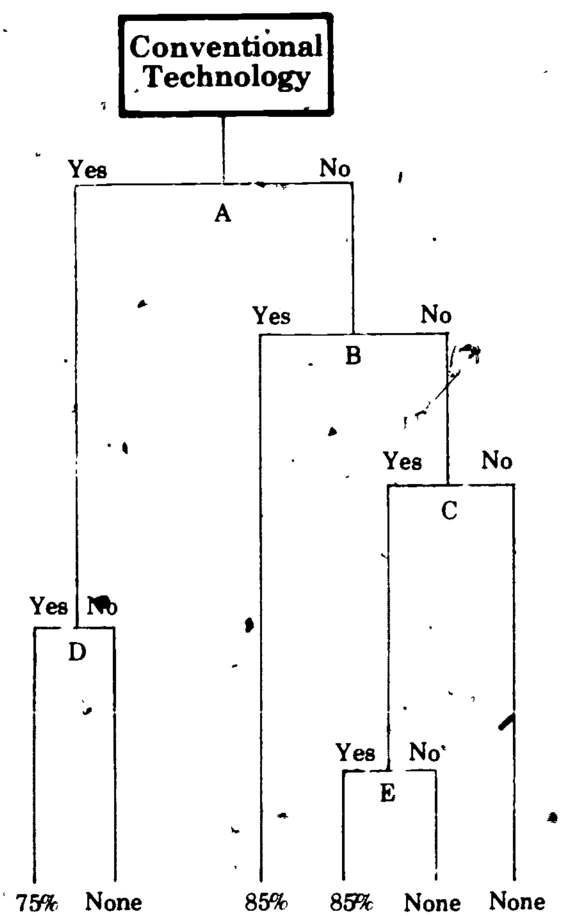
B. Satisfies 15% life-cycle cost reduction?

C. Meets 20% net energy reduction?

D. Most cost-effective alternative?

E. Cost-effective? within 15% of most cost-effective conventional alternative

Funding



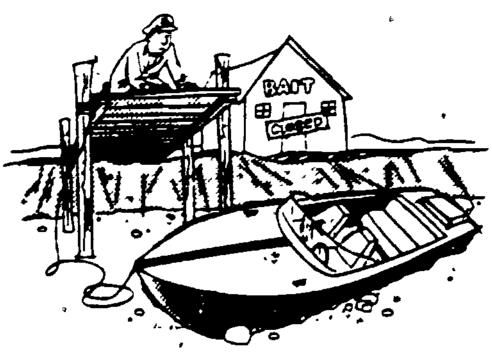
Chapter 8.

Water Conservation and Reuse

Charles A. Cole

Why Conserve or Reuse Water?

Man's existence and cultural development has revolved around water. Water is used for drinking as well as transportation, industry, commerce, and waste disposal. Most large population or industrial centers are located on, and critically dependent upon, good water supplies.



Water Shortages

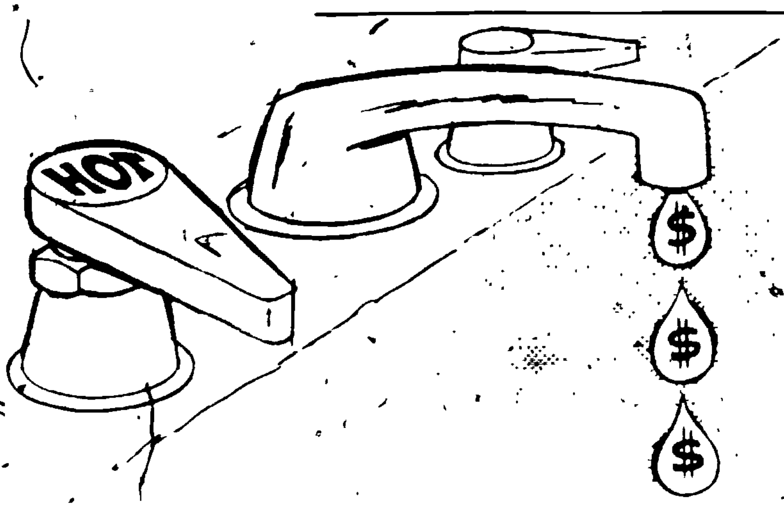
Some areas of the United States have abundant supplies of high quality water that meet year-round needs. Other areas have only a limited supply of water of acceptable quality. Numerous examples of chronic water shortages can be found in the Southwest. Other geographical areas face seasonal shortages. Salt water intrusion is a serious problem in coastal areas where groundwater has been seriously depleted. Yet in other cases where there is adequate water quantity, the quality makes it only marginally usable. Examples include the acid mine drainage water of Appalachia, and water containing high levels of dissolved solids found in the Southwest. Periodic droughts combined with an inadequate water supply produce a crisis situation. The Northeast suffered its worst long-term drought from 1961 to 1965 California suffered a devastating drought during 1976 and 1977. Other more localized droughts occur every year, and have a significant effect on communities. *The need for water conservation becomes more important in light of increasing population and increasing per capita demand*

Wastewater Treatment Plant Overload

Wastewater treatment plants have to be adequately sized to meet the wastewater flows produced by the community. However, industrial, commercial, and residential users often produce excessive flows. These large flows overload the treatment system, which then cannot function properly Reduction of these wastewater flows by water conservation may make the facilities last longer or produce effluent of improved quality. However, excessive infiltration and inflow (I/I), which are leaks of ground or surface waters into sewers, may overshadow any benefits that result from water conservation **In these cases the citizen advisory group should promote control of I/I as well as water conservation.**

Onsite Disposal

Onsite wastewater disposal from a septic tank is used by 29 percent of the total households in the United States More would be used, but the soils and topography of many sites are not well-suited for the effluent disposal. For example, 80 percent of Pennsylvania's land is unsuitable for onsite systems. Water conservation reduces wastewater flows and offers the potential for improved treatment on many sites. It also permits disposal on some previously unacceptable sites.



Energy

Energy can be saved by water conservation By using less water, sizable savings in electrical consumption for pumps, and electricity or fuel used for hot water, can be realized Additional savings result through reduction in chemical usage at treatment plants Part of chemical costs represents the energy consumed in mining, manufacture, and transportation of the materials

Regulatory Policy

The Clean Water Act of 1977 recognizes that water conservation will improve water quality It includes provisions that encourage economic water saving measures. Water conservation increases both efficiency and longevity of treatment facilities. If the amount of water treated by a plant can be reduced, the size of the plant and the operational costs can also be reduced This will extend federal dollars for pollution abatement and permit the construction of more treatment plants

Section 104 of the Act requires the United States Environmental Protection Agency (EPA) to conduct research into methods that can reduce wastewater flow Section 201 states that the EPA shall encourage wastewater treatment technology that reclaims wastewater for other uses. Section 201 also requires the consideration of innovative and alternative technologies that result in water reuse and recycle The Act provides increased funding for those projects using alternative technologies, raising the federal share from 75 percent to 85 percent of construction costs

The Safe Drinking Water Act of 1974 takes another approach to water conservation by providing funds for demonstration projects that will investigate the health implications of reuse and recycling of water for potable use

President Carter in 1977 asked the federal government to review water resource policy "with Water Conservation as its cornerstone " Specific directives to federal agencies include

- Requiring water conservation as a condition of federal funding for water supply and wastewater treatment grants of the EPA, housing programs of HUD, and USDA, and contracts for water supply from federal projects of the Bureau of Reclamation, USDA, DOE, Army Corps of Engineers, and the TVA
- Requiring water conservation in federal buildings
- Encouraging water conservation in agricultural assistance programs, and providing technical assistance in water-short areas

Cost-Effectiveness Analysis

The EPA requires evaluation of the cost-effectiveness of flow reduction measures during Step 1 planning of the 201 construction grant process However, this is required only if the community is larger than 10,000 people, and average water use is greater than 70 gallons per person per day The water conservation alternatives include water pricing changes, use of water meters, use of low flow devices such as toilet dams in homes, public education, and changes in plumbing codes to require installation of water-saving devices in future homes

Savings in water and energy at the present and 20 years into the future are to be analyzed. Water and sewage treatment and transmission costs are also to be considered, both with and without conservation measures

Plumbing Codes

Many communities have adopted plumbing codes requiring the installation of residential water-conserving devices in new construction. The first area to adopt such a strategy was the Washington Suburban Sanitary Commission in Maryland because of short water supplies in the Potomac River watershed and overloaded wastewater treatment plants

Similar measures have been legislated in California and Georgia. Other states are also considering plumbing codes that promote water conservation.

Water Use and Wastewater Production

Water use and wastewater production go hand in hand. For example, 90 percent of municipal waters end up in the sewer Water conservation thus alleviates both supply and disposal problems because water that is not used doesn't have to be treated

Industrial, Commercial, and Agricultural Uses

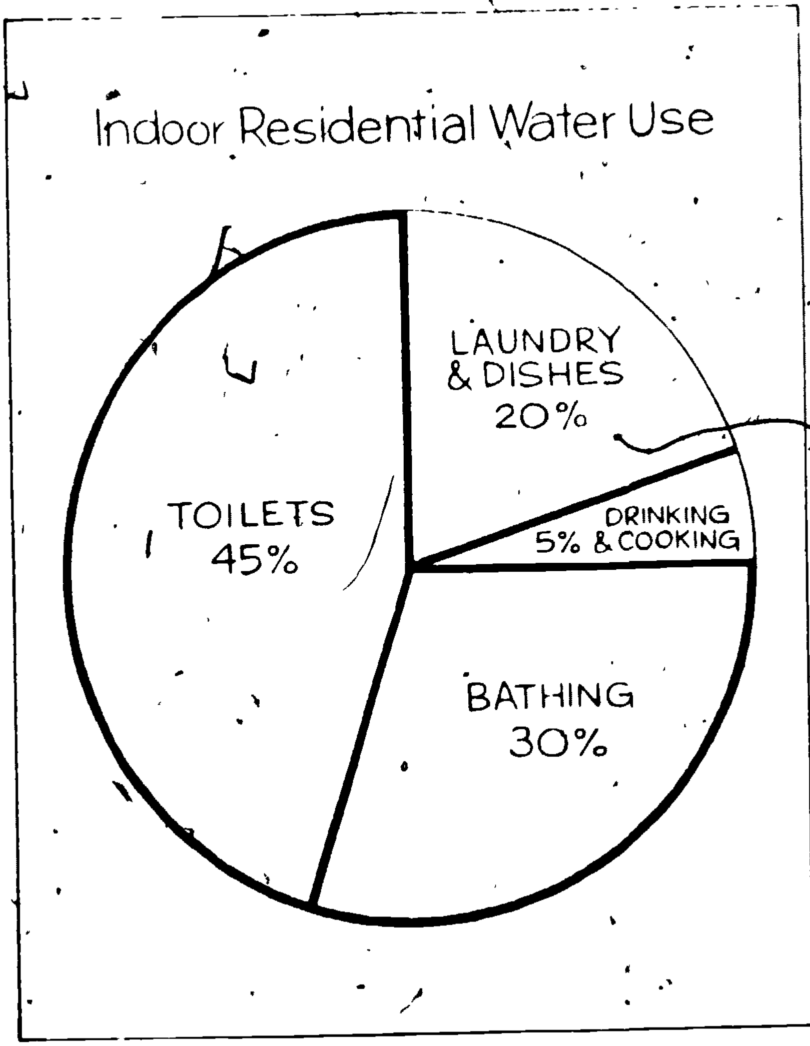
Industrial water accounts for 40 percent of the water used in the United States Industrial wastewater production may be the easiest to control. Industry often must treat water before using it, and is motivated economically to recycle its wastewater and conserve water It may be possible through a change in water rates to significantly reduce industrial flows. The trend in many water-consuming industries is towards the total recycling of water within the plants. Potable water use and sanitary waste production are often only a small part of industrial flows.

The volume of water used by commerce (i e., businesses) is not as great as the volume used by industry However, water used for human consumption and sanitation, such as drinking, bathing, washing, and toilet use, makes up a much larger fraction of the total commercial use. Therefore, many residential water conservation devices are applicable to commercial situations. Commerce, like industry, is motivated by economics and changes in pricing may have significant impacts.

Agricultural water use is related to the crops grown and the geographic area. Agricultural water use accounts for 50 percent of total United States water use Many new techniques are being developed to reduce irrigation water needs.

Residential Uses

Residential water use has not been seriously studied until recently Generally accepted average use of individual systems is 50 gallons per capita per day, and for public systems it is 73 gallons per capita per day. The two major household uses are for bathing and toilets.

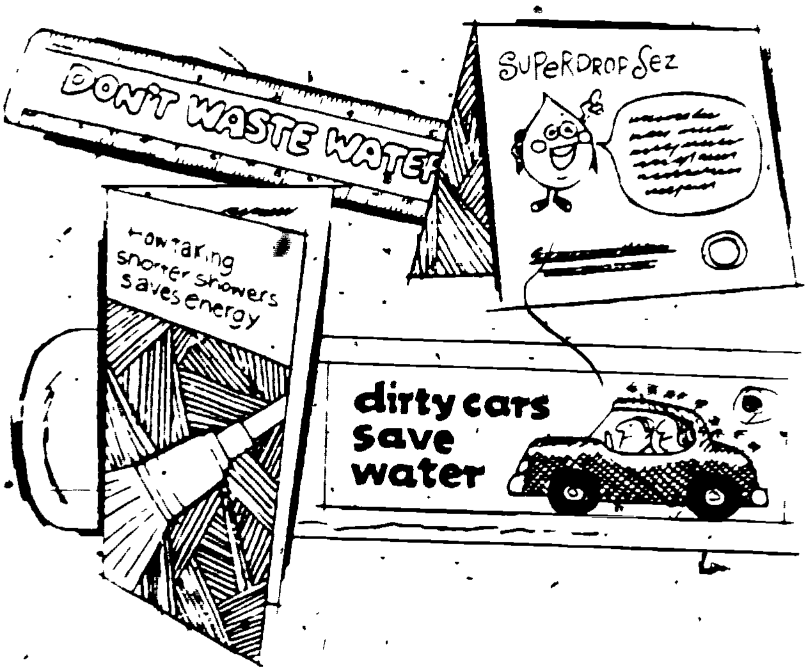


Implementing Water Conservation Plans

Public education is a key to water savings. Although it is difficult to evaluate the actual savings from an education program water reductions of 20 percent appear possible without too much hardship. One effective municipal district's public education campaign took the form of:

- Printed inserts included with water bills
- Posters placed throughout the community

- Reminder items such as buttons, key chains, matchbooks, and litterbags
- Public service announcements on radio and TV
- Speakers and motion picture films sponsored by the utility
- Help from volunteer groups
- Conservation education programs in schools

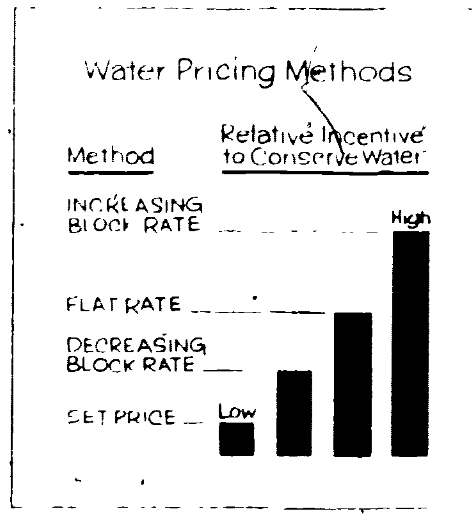


The advisory group can recommend a water conservation program for its community. The agency or body that has a vested interest in conservation will be the most willing to support such a plan. Water utilities with supply problems can be very effective. Overloaded wastewater treatment utilities can also actively participate. If the conservation objective is long term, not merely a solution to an immediate problem, it may require different action. Then the local or state government may need to start an education program. The advisory group should be sure that water conservation is carefully considered during the cost-effectiveness analysis of facility planning.

Pricing

Water pricing can impact the consumption of water. Most utilities establish rates to recover the cost of services, high rates can accomplish much more. It may be necessary to encourage your utility to review traditional pricing policies in light of water shortages or water quality difficulties. These reviews can be encouraged by public education and legislation

There are several types of water rates They have different impacts on consumption Major pricing approaches are the set price, the flat rate, the decreasing block rate, and the increasing block rate



Set Price

With this rate structure each group of customers pays a set price for any amount of water consumed The bill is the same whether 1,000 or 10,000 gallons are used each month This type of structure must be used when there are no meters The price offers no incentive to conserve water because the price is not linked to the quantity of water consumed

Flat Rate

In this pricing arrangement the unit price of water is constant no matter how much is consumed The cost to the customer increases in direct proportion to the amount of water consumed There is an incentive to conserve, but it is the same for both large and small users

Decreasing Block Rate

This rate structure is widely used by utilities today. The consumer pays a certain unit price for a volume, a lower unit price for the next volume, and so on. The cost of the water to the consumer increases as consumption increases, but at a decreasing rate. The incentive to conserve water decreases as consumption increases. In fact, the largest consumers have the least incentive to conserve.

Increasing Block Rate

The unit price of water increases in a stepwise manner under this rate structure. It is opposite of the decreasing block rate This type of structure is justified, when the cost of water increases as demand increases. It provides an excellent incentive to conserve water

Two other pricing strategies are possible One is the "peak demand rate" which aims to flatten usage at high consumption times of the year or day The other approach, the "life-line rate", provides a minimum amount of water at a small cost to all people. The life-line rate benefits people on fixed incomes such as the elderly.

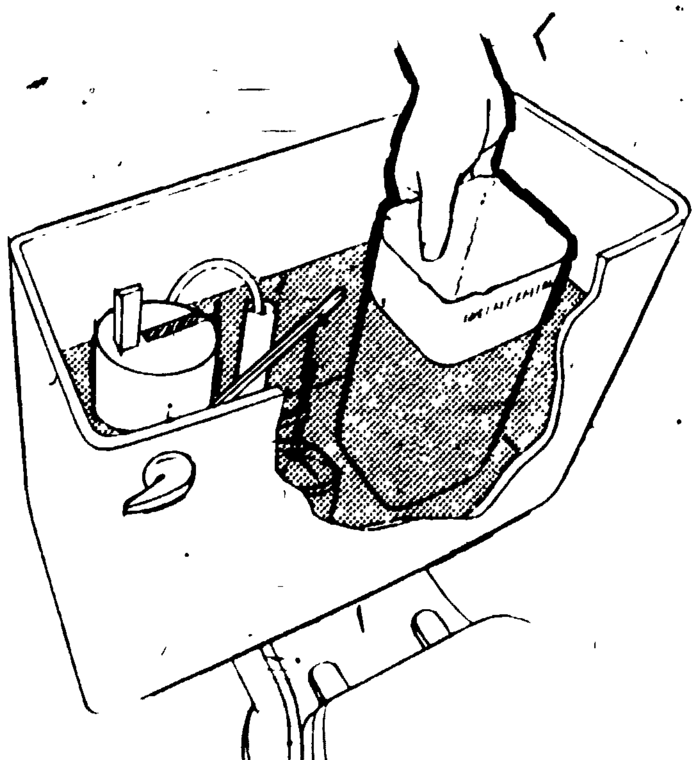
Water prices can be a most effective conservation tool. Upon recognizing the need for water conservation the advisory group should meet with the people responsible for water pricing. If the supplier is a non-profit government agency, it may be easier to adopt rates which encourage conservation. Private utilities may be more reluctant to change anything that will reduce their water sales. The advisory group may present examples of savings caused by changes in pricing. This action followed by an education campaign to mount public pressure may achieve some price changes.

Residential Water Conservation Devices

Residences use public water and generate wastewater. Each year there are more residential users. Each year many individuals use more water than the year before. The result can severely strain the capacity of water supply and wastewater treatment facilities. Residential water-conserving devices alleviate overload problems, or postpone construction of new supply or treatment facilities. The toilet and bath offer the greatest potential for conservation, since 75 percent of residential water is used there

Toilet Devices

Adoption of the flush toilet may well have been one of man's worst decisions about disposing human wastes Each of us use daily about 25 gallons of drinking water to flush wastes down the sewer The conventional toilet, using 5 or more gallons of water per flush, can be modified to reduce water consumption Plastic bottles filled with water and pebbles can be added to the reservoir tank in order to displace water. Several commercial devices serve similar functions. These devices can save as much as a gallon per flush. Recently many new types of toilets have come onto the market which reduce water consumption



Water Use for Various Toilet Systems

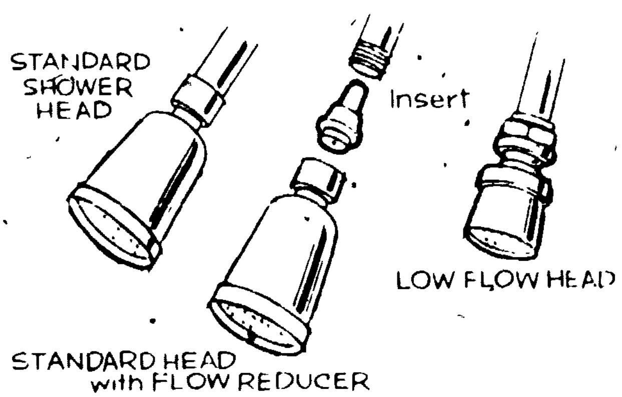
Type	Mechanism	Sewage Production Gallons/Flush
Conventional Water Closet	Water Carrier of Wastes	4 8-5 5
Conventional Water Closet	With Bottles or Dams Tank Volume Displacement	3 7-4 5
Modified Water Closet	Dual Flush Cycle and/or Reduced Tank Capacity	1 0-3 5
Vacuum or Air Toilet	Air or Vacuum Treatment	0 3-0 5
Recirculating Toilet	Filtered and/or Chemically Treated Water Recycled From Holding Tank	0 1-0 2
Incinerating Toilet	Liquids Evaporated and Solids Incinerated by High Temperature in Either Gas or Electric Furnace	0
Waterless Toilet	Composting or Oil Carrier Fluid with Incineration	0

Two types of conservation toilets, more properly called modified water closets, are now used in the United States The more common water-saving toilets use 3 5 gallons per flush in contrast to the 5 gallons needed by the conventional types These water-saving toilets look and function the same as conventional types, but accomplish a savings of 30 percent in water use Dual flush systems, common in Europe, are rare in the United States They can drastically reduce water use The dual flush toilet has a 1 5 gallon flush for liquids and a 2 5 gallon flush for solids They have a wall-mounted tank with a pipe running to the bowl mounted to the floor

Recirculating toilets using chemically-treated water, incinerating toilets, and composting toilets are other options These devices offer potential for rural and vacation homes where sites on land are unsuitable for septic tanks However, they are relatively expensive

Showerheads

Bathing represents the next largest amount of residential water consumption Great potential exists for saving water (and energy used to heat water) Public attitudes play an important role in acceptance of the devices Fortunately, showering is more common than bathing and has greater potential for water conservation Simple devices can be inserted by the homeowner to reduce flows by restricting water at the showerhead However, it is often just as easy and more effective to replace the showerhead with a new inexpensive water-saving model Water savings in the range of 50 percent are feasible without customer dissatisfaction Spray devices installed on lavatory and kitchen faucets will improve water use



Water-Saving Washers

For years water-saving clothes washers called suds savers have been manufactured. However, lowering water levels and improved rinse systems can reduce water use up to 50 percent for clothes washing. Improved dishwashers have reduced water consumption by up to 38 percent.

Lawn Sprinkling

Some areas of the country depend heavily upon irrigation to keep their flowers, lawns, and valuable shrubs in good condition. Improved methods such as underground trickle irrigation can reduce demands considerably. The best conservation alternative for landscaping is to use native vegetation that can survive naturally in the existing climate without supplemental water

Pressure-Reducing Valves

Lowering water pressure in a residence can reduce water usage. Many fixtures and appliances consume less water as pressure drops, but still perform adequately at minimum pressure It is advisable to reduce maximum pressure in residential piping to 40 pounds per square inch. This can be done by installing a simple valve at your residential water inlet.

Economics

The potential annual net savings from installing retrofit devices in an existing suburban household was estimated at $54 in 1978 by the EPA. The installation of new devices in a new suburban home was estimated to save $96 annually.

The advisory group can encourage agencies or utilities to start a public education program to promote water conservation and water-saving devices. The advisory group can help citizens locate plumbing distributors stocking the devices. The residents should get advice from their water suppliers on how to measure the water use before and after the devices are installed, and how to check for leaks.

Things to Consider in a Water Conservation Plan

Two areas of caution relate to water conservation consumer and utility company acceptance, and device and collection system maintenance. Most people are willing to make some change in habits, if they have good reasons Education and good public relations are the keys to consumer acceptance

Some water utilities have traditionally been opposed, or at least indifferent, to water conservation. As long as there was sufficient supply and no restriction on disposal, added volume or usage meant added profits. However, faced with the problems of limited supplies and consumer complaints over increased costs, attitudes are changing. Nevertheless, utilities agree that water conservation may increase rates. This results from the utility's high fixed costs, which remain unchanged no matter what volume of water is sold. The

Potential Savings for Installing Devices in a Typical Suburban Household

Type of Construction	Devices	Daily Water Saving	Annual Savings per Household*
1. Retrofit in Existing Homes	Displacement toilet dams Fine spray showerheads	49 gal (23%)	$54
2. New Homes	Water-conserving toilets Fine spray showerheads Water-saving clothes washer Spray on lavatory faucets Water-saving dishwasher	74 gal (35%)	$96

**Includes in-house hot water energy saving*

utility's costs go down, but the cost to any given user may go up, down or remain the same. The means of making the rate impact equitable for all users depends on pricing policies.

Extensive water conservation has caused some problems for wastewater collection and treatment. During a severe drought in Marin County, California, it was necessary to flush sewers to transport solids when sewage flows dropped to 25 percent of the normal amounts. Modest reductions in flow produce no adverse effects. It is also expected that pollutant concentrations in the effluent from some treatment plants may rise as flow goes down, but overall removals in terms of pounds of pollutants per day will decrease. On the other hand, many already overloaded plants produce improved effluent when flows are reduced.

Toilet retrofit device maintenance can be a problem. Some makes of toilet devices may cause double flushes Others occasionally become displaced and cause toilet malfunctions. They are simple to repair if the user is aware of the problem. Any conservation program using toilet retrofit devices should evaluate the device prior to its adoption

Reuse

The reuse of water has been going on for a long time. Reuse occurs through the hydrologic cycle, groundwater recharge from septic tanks, and upstream-downstream uses of water For example, it is estimated that water is reused seven times on the Ohio River in its journey from Pittsburgh to the Mississippi River.

Recently large-scale controlled reuse of water has been implemented. Reuse may take many forms Examples include agricultural and residential irrigation, impoundment in lakes for recreation and wildlife, groundwater recharge, industrial cooling, and consumption for both drinking and industrial processes.

Municipal wastewater recycle for potable use (drinking water) began in South West Africa in 1970. Municipal sewage is reclaimed by physical/chemical treatment to make up 30 percent of the public water supply. No such direct potable use is made in United States. Customer acceptance is expected to be a major problem even if public health considerations are satisfied. Municipal wastewater has been revised in the United States for industrial cooling water and agricultural or horticultural irrigation water. Land treatment of wastewater is really a form of reuse. A good example is Muskegon County, Michigan, where effluent provides irrigation water for crops. The crops remove the nutrients from the wastewater before it is returned to the stream or groundwater. Municipal wastewater also can contribute to recreational lakes. An example is the Santee project in California

Industrial "closed loop" with internal recycle of water has been performed for many years. However, it is being considered by more industries as we move towards the 1985 goal of The Clean Water Act; the "zero discharge" of pollutants.

Agricultural irrigation reuse is common, but it may cause additional downstream use problems because of higher total dissolved solids in the water. Residential reuse (recycle) has been investigated in several demonstration projects. Treatment, storage, and reuse for toilet flushing and lawn sprinkling are considered to be economical only for problem onsite disposal areas and high water cost areas. However, dwindling water supplies and rate increases may make residential reuse more attractive.

Many innovative and alternative technologies reuse and recycle water. Many result in aquifer recharge. Others produce saleable energy and marketable crops. This revenue reduces operation costs Multiple use is another form of reuse. Municipal wastewater reuse projects qualifying as innovative and alternative technologies may receive 85 percent federal funding in the Construction Grants Program. This is an increase of 10 percent over projects utilizing conventional treatment methods

An advisory group can encourage the grantee to consider the wastewater as a resource rather than a liability. This wastewater can be valuable in water-short areas. However, the nutrients in wastewater are also a resource that has made land application attractive even in areas with adequate water supplies. Water reuse requires public acceptance and support. An advisory group can promote water reuse through the public and the organizations that it represents. In several instances land treatment has been opposed because of the public fear of health hazards. Decades of research has dispelled most of these concerns. The advisory group can help to alleviate fears by explaining the facts. An advisory group can ask that these options be considered during facilities planning.

Conclusions

There are many reasons why water should be conserved. The most obvious reason is a limited supply. Less apparent, but just as valid, reasons include: wastewater load reduction, reduction in water pollution, energy and chemical savings, and potential for reduced capital investment for both water treatment and wastewater treatment facilities.

Probably the greatest potential for reduction in water usage lies with industry. However the best opportunities for public water savings is in residences, where 45 percent is used for toilets and 30 percent for bathing How to reduce water usage is a multifaceted problem. Public awareness and education coupled with changes in pricing, regulation, and plumbing codes can result in dramatic savings in water and energy The most tangible economic benefit to consumers is in reduced energy bills

Residential water conservation may be obtained using readily available devices which require little or no change of habits for their usage Water-conserving toilets and showerheads are best for new construction, while retrofit devices may be easily installed in existing homes.

Controlled water reuse is another option Resource and economic benefits can be gained by reusing or recycling water or wastewater effluent for agricultural, industrial, and other purposes.

The exact scheme chosen for water conservation in your area will depend on the particular needs of your community. These can be determined through Section 208 studies, as well as 201 facilities planning. Remember that water conservation and reuse may not completely solve your water pollution problem, but they can be useful tools.

Water conservation and reuse must be evaluated during the cost-effectiveness analysis conducted as part of facility planning. The advisory group should insure that the conservation and recycle alternatives are given adequate consideration

Uniform Rate Structure, Retrofit, and Education

Elmhurst, Illinois

Excerpted from "Two Cities Meet Conservation Challenge", Myer, L et al Water and Sewage Works, pp 60-61, March 1979

Elmhurst, Illinois, is a community of 50,000 people that solved a water-supply shortage through water conservation Its water is supplied primarily from deep wells Since 1957, withdrawals had been exceeding the rate of recharge Also, the sewage treatment plant had reached its hydraulic limit

Program

Elmhurst's goal was to

- Reduce water consumption by 10 to 15 percent and sewage treatment plant hydraulic loads by 8 to 10 percent
- Reduce both maximum day and peak-hour consumption
- Eliminate the necessity for a new deep well

An important part of the water conservation program was public education This included

- A water bill mailing insert
- Newsletters sent to all residents describing the water-supply problem and conservation program, with suggested methods to conserve water
- Local newspaper, radio and TV coverage.

Until 1975, Elmhurst used a declining block rate structure (unit charge decreased as consumption increased) for water and sewer service It decided that the most equitable rate structure for a primarily residential community was a uniform unit charge rate, independent of consumption volume In late 1975, Elmhurst instituted an excess usage water rate, based upon findings that a small percentage of users were responsible for the high summer water demands The water system was designed for the summer peak-hour and maximum daily consumption So, it was underused in the winter The new rate charged the cost of excess supply and storage capacity to the users responsible for it.

To save significant amounts of water quickly, Elmhurst delivered to each home a set of toilet displacement dams, restriction device for showerheads, and dye tablets to check for toilet-flush leakage The community spent approximately $1 per person for the public education program, purchase of water-saving devices, and labor.

Results

Preliminary results show that

- The nine wells previously needed to meet summer peak demand were reduced to seven
- Water consumption was reduced by 15 percent
- Wastewater loads were reduced by 10 percent, providing additional capacity for 5,000 people
- Expenditure of $400,000 for a new deep well was deferred

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Plumbing Code Change and Retrofit Program

North Tahoe Public Utility District, Nevada

From presentation made by Hassenplug, J and Esking, N at the 1978 American Water Works Association Conference in Atlantic City, NJ, "Water Conservation Methods Practical and Legal Aspects", June 1978

The North Tahoe Public Utility District is a public entity operating a domestic water supply and distribution system serving a part of California and Nevada. The area is primarily comprised of second homes, condominiums, motels, and some commercial establishments. Tourism is the primary industry. Approximately 25 percent of the housing stock is occupied year-round.

The District began developing a water conservation program in January, 1976, as a method for reducing sewage flows, although realization of a severe drought in California was just beginning.

Problem

Implementation of a water conservation program was a major problem, since:

- Many operators of tourist facilities believed water conservation restrictions would infringe on the visitors' enjoyment of the area and disrupt tourism
- There were few other programs to imitate and information on water-saving devices was sketchy
- Legal basis for operating the program was uncertain
- Governmental structure also hampered the program.

Within the Tahoe basin, relevant governmental entities included: the federal government, two states, five counties, the Tahoe Regional Planning Agency, The California-Tahoe Regional Planning Agency, and the Nevada-Tahoe Regional Planning Agency, as well as numerous public utility districts and private water companies.

Program

The program objective was to achieve water conservation in a passive manner without requiring or prohibiting direct action by water users. This was particularly important because of the transient population.

The District had ordinance-adopting powers pursuant to state law, but depended upon Placer County for enforcement. Working closely together, the District and the County adopted essentially the same ordinance, presenting a united front to the utility user. The county ordinance was also effective over a wide geographical area, encouraging other districts to conserve water

The following design for a water conservation ordinance was given

1 The ordinance distinguished between different classes of water use, and between existing and new construction

2. Certain types of conservation were mandated. These were all physical installations and not changes in human actions. The devices used were water-saving showerheads, aerators, and toilets. Self-closing lavatory valves were mandated under certain conditions

3. A retrofit education program was developed to convince users that both new and old users were treated fairly Further, the District conducted most retrofit programs to insure proper installation.

4. A timetable was set forth for compliance: 30 days after adoption for all new users and 8 months for retrofitting. Failure to conform involved penalties of $500 for each day after notification, and shutoff of services if compliance was not forthcoming.

Conservation device selection was made by ordering several types of each device and subjecting them to tests.

The estimated cost of the retrofit installation program was based on these assumptions: two toilets/house, two showers/house, one man-hour/house for installation, and 0 4 man-hour/house for follow-up service for installation in ten percent of the houses. Installation teams operated in pairs, preferably of mixed sexes. Shower flow devices and toilet tank dams were scheduled for initial installation. Faucet aerators were scheduled for the second and third years of the program. This enabled crews to check initial installation and review of the program with the customer.

Very few problems were encountered by the crews In places where the dams wouldn't fit, plastic bottles were used. No bricks were used. In the case of vandal-proof showerheads and in cases where the showerhead would not fit the device, a new shower arm or showerhead was installed. Complaints were rare. Public cooperation and support were excellent due to the large amount of publicity given the program.

The publicity program of radio announcements, press releases, and flyers, sent with all water bills preceded door-to-door canvassing The flyers also provided information for making appointments to have the service done The publicity campaign also included poster and essay contests, a water conservation fair, and distribution of water conservation buttons, T-shirts, balloons, and stickers. Area restaurants were provided with table tents and posters indicating water was available on "request only" In addition a school education program was tied in with the current science curriculum

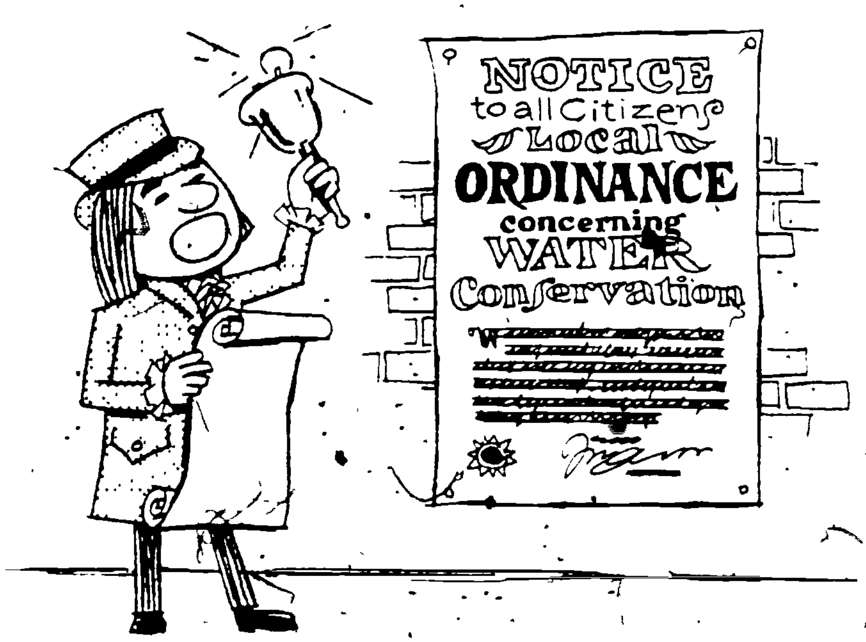
Results

The average water savings for 12 area motels was about 40 percent during the second and third quarters of the year. These periods do not include ski seasons in which usage is highly variable. Several lessons were learned during the program. They include: Different water-saving devices will be needed for a program Devices should not be purchased all at once since better ones may appear on the market at any time. Good publicity, education, and public relations are essential aspects of a program.

The following suggestions are offered for implementation of a water conservation ordinance

1. Analyze the political structure of the area where the legislation is to be effective. It is desirable to coordinate the adoption and implementation of the rules with the agencies most involved with enforcement

2 Avoid allying a program with a controversial agency, particularly with a planning agency involved in growth control Such action will have the effect of linking the program with controversial and negative issues, thus diminishing public cooperation



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Peak Demand Surcharge Rate

Dallas, Texas

Excerpted from: Water Conservation—A Practical Approach", by Rice I and Shaw L. Journal of American Water Works Association, p 481, 482 September 1978

Education and information have long been tools in the Dallas, Texas, water conservation program. Their primary value, however, has been supplemental to more direct conservation measures. The Dallas solution was to use pricing policy as a tool to achieve conservation of water resources. A pricing policy must be tailored to the circumstances of an individual community, whose leaders and administrators best understand where significant conservation is possible and how it can be achieved. In the United States the price mechanism is easily understood and its impact is readily assessable. Three elements—knowledge of customer water use, customer understanding of rate structure, and customer ability to assess economic impact of conservation measures—are essential to an effective water conservation program.

Program

In Dallas the customer having the most potential for significant water conservation is the single-family residential consumer. The hot, dry summers typical of northcentral Texas from June through September create a heavy, but relatively short-term demand for yard irrigation to preserve grass, shrubs, and trees. Therefore, the initial focus of the Dallas conservation program was directed to the high-usage residential consumer during summer months. The program objectives were twofold: To lower (1) the average residential consumption, and (2) the peak-hour and maximum-day demands upon the treatment and distribution system, as compared to previous years under similar weather conditions. The first objective was an attempt to reduce the need for future supply reservoirs, the second objective tried to reduce the need to expand the capacity of water purification plants and the distribution systems. The strategy was to formulate a rate structure based on cost of service to accomplish these objectives.

A number of approaches to changing the residential rate structure were considered. Dallas chose to adopt and implement a surcharge for monthly consumption above a specified level during the summer months (June-September). In 1976 a major fraction of the water was consumed by large users (above 20,000 gallons per month). It was felt that the rate structure must affect these users if a significant impact on traditional consumption patterns was to be achieved.

Dallas, Texas, Rates for Water Service: 1977

Monthly Consumption	Old Rate $/1000 gal	New Rate $/1000 gal	Rate Increase Percent
First (8,000 gal)	0 58	0.61	5
Next (12,000 gal)	0 51	0 61	22
Over (20,000 gal) (winter months, Oct.-May)	0 50	0.61	22
Over (20,000 gal) (summer months, June-Sep.)	0 50	0.79	58
Overall increase in revenue requirement			12

Results

The results of the first summer's experience with the new surcharge feature and other rate structure modifications must be considered preliminary but they do seem extremely encouraging. For example, the maximum-day to average-day demand in 1977 declined 8 percent from the average of the last five years, even though weather conditions were the same or more severe than those experienced during any year of the last five-year period. Also, the maximum-day pumpage in 1977 declined 12 percent from that experienced in 1974. If the preliminary view is correct, the new pricing policy may have saved the Dallas system the equivalent of a 50 to 75 mgd treatment plant at no cost.

It is believed that Dallas is the first major city to adopt a pricing policy that places a surcharge on heavy demand residential customers during peak usage periods. In Dallas this represents a stage in evolution from a pricing policy that, over 25 years ago, gave a declining rate to heavy consumers, to the policy adopted in the 1950's of a flat rate, to the present system of heavy-demand surcharge. When the current rate structure was presented to the city council for approval, the surcharge portion of the rates was described as a response to a previously expressed desire of the council to increase water conservation in Dallas.

Recycle and Reuse
California

Excerpted from "Water Conservation Through Wastewater Reuse", by M L Wasserman, Proceedings of National Conference on Water Conservation and Municipal Wastewater Flow Reduction, November 28, 29 1978 Chicago, IL sponsored by the EPA EPA 430/9-79-015, August 1978

The following case studies illustrate a variety of reclaimed water producers, users, and industrial recyclers:

• **Burbank Power and Light.** About 10 years ago, the City of Burbank was sending all its wastewater to the City of Los Angeles for treatment and disposal To reduce the cost of wastewater disposal and to conserve water, Burbank built a 7 mgd sewage treatment facility with outflow supplying the 1 2 mgd cooling water requirements of the Burbank Power and Light generating station

The cost of city supplied water is much more expensive than reclaimed water City water in 1978 sold for more than five times the cost of reclaimed water In terms of costs for water purchase and including chemical treatment to control pH, scaling, hardness, and coliform organisms, total cost savings to the power plant amounted to $6,300 per month

• **Simpson Paper Company.** Simpson Paper Company's Shasta Mill near Anderson, California, operates under some of the most stringent water quality regulations in the United States The regulations are tight because the mill discharges to the Sacramento River, a highly productive fish spawning ground Wastewater discharges resulting from a plant expansion in 1974 could not be economically treated to meet discharge standards. The company then investigated the use of secondary effluent for irrigating croplands

Presently the mill produces 2 6 mgd of reclaimed water for irrigating 650 acres of cropland A fully automated flood irrigation system is used to supply the water to the land Good yields of oats, wheat, and field corn are achieved

This land has highly permeable soil, which allows the effluent to percolate rapidly to the riverbed. During the recent drought when Sacramento River flows were very low, the Shasta Mill was able to meet the most stringent conditions prescribed in its discharge permit.

• **Irvine Ranch Water District.** In 1972 the Irvine Ranch Water District adopted a water resources master plan which provided for maximum use of the District's total water resources, including fresh water supply, the collection and treatment of wastewater, and the extensive use of reclaimed water. In assessing options for effluent disposal, the District chose a total reclamation and reuse alternative, rather than ocean disposal Two key points became evident in the analysis of the alternatives First, the degree of treatment had become virtually the same for the two alternatives largely because of increasingly stringent water quality standards for ocean disposal Second, the cost of the total reclamation program was $1 25 million less per year than the ocean disposal route—mainly because the District could earn a potential $4 million annually by selling reclaimed water Presently, it supplies 5 mgd of reclaimed water for irrigation of citrus orchards, vegetable crops, parks, community greenbelts, and golf courses

The District sells reclaimed water for $69 06/ac-ft. compared to the $143 75/ac-ft charge for Colorado River water imported for domestic uses High in nitrogen and phosphorus, the reclaimed water is calculated to have a fertilizer value of $30/ac-ft, which at prevailing irrigating volumes comes to about $120/acre/yr. To the farmer this means fertilizer cost-savings on top of the water cost-savings obtained by purchasing reclaimed water at half the price of freshwater.

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Need More Information?

A Pilot Water Conservation Program. Bulletin 191. Sacramento, CA: California Department of Water Resources, October 1978 64 p.

This bulletin reports on a study of the best and most cost-effective ways to introduce water-saving devices into homes. The study includes pilot programs in six California cities that were affected by the severe 1976-77 drought The study will be of value to water suppliers and citizen groups interested in water conservation Eight appendices are also available, including a device study and the study of each of the six cities. The report is available at no cost from California Department of Water Resources, P.O. Box 388, Sacramento, CA 95802. attn Dean Thompson

Agricultural Water Conservation Conference Proceedings Sponsored jointly by California Department of Water Resources and the University of California Cooperative Extension Service, June 1976 249 p

These proceedings resulted from a conference on agricultural water conservation in California, however many of the conclusions are applicable nationwide. Both approaches and policy are discussed in these proceedings. It is available from California Department of Water Resources, P O Box 388, Sacramento, CA 95802; attn Dean Thompson

Directory of Federal Programs Related to Water Conservation Draft copy Washington, DC U.S Environmental Protection Agency, Office of Water Programs Operations, November 1978 72 p

This is a directory of federal programs by agency including type of assistance, nature of program, water conservation provisions, eligibility, fiscal scope of program, applicant eligibility, and informational contact It is available from EPA, Facility Requirements Division (WH 595), 401 M Street, S W , Washington, DC 20460

Milne, M *Residential Water Conservation*. California Water Resources Center Report No 35 Davis, CA University of California, 1976 469 p

A comprehensive but non-technical report on residential water conservation covering factors influencing water use, devices, and applications It also discusses costs of treatment of wastes and laws from the California viewpoint It is available for $14 50 as order no. PB-253-253/9 from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161

McGhee, R , et al., eds. *Readings in Water Conservation*. Washington, DC National Association of Counties Research, Inc., 1978. 332 p

This document represents an extensive collection and synthesis of recent publications in water conservation. Areas covered extensively are regulations, infiltration and inflow, devices, education, land use, planning, pricing policies, economics and reuse. This collection represents national scope Copies may be obtained from National Association of Counties Research, Inc., 1735 New York Avenue, N W., Washington, DC 20006

Water Conservation Devices, Residential Water Conservation. Water Research Capsule Report Washington, DC. U S Department of Interior, Office of Water Research and Technology, 1977. 10 p

This capsule report highlights findings of research projects funded through the Office of Water Research and Technology. It is a simple overview of the subject and is suitable for lay persons desiring information on residential water conservation It is available from Superintendent of Documents, U S Government Printing Office, Washington, DC 20402 as Stock Number 924-000-00834-1, at a cost of $0 90 per copy

Chapter 9

Land Treatment

David A. Long*

What is Land Treatment?

It is an old idea that has come of age—in the West, that is. Orientals have recycled human wastes for centuries. Although this approach is based on the same principle, it is a different practice. Eastern cultures such as China use waste solids called "night soils." In the United States wastewater is used. Called land treatment or land application, it means *applying wastewater to land* rather than discharging it into lakes and streams.

When wastewater is put onto land a whole series of physical, biological, and chemical actions take place. The soil acts first as a filter to strain out suspended solids. The remaining bacteria and dissolved materials are broken down biologically, or become absorbed into the soil. Plants growing on the ground surface also play an important role by removing water and nutrients such as phosphorus. The land treatment process is truly a "living filter" at work.

When Should Land Treatment Be Considered?

When should land treatment be considered? Always!

The Clean Water Act of 1977 is clear. Communities seeking federal funds for wastewater treatment systems *must* consider land treatment as an alternative treatment method. Land treatment is one of three broad categories:

- Treatment and discharge into surface waters (conventional waste treatment)
- Reuse of treated wastewater
- Land application and utilization practices.

Land Treatment in the United States

Advantages of Land Treatment

Land treatment has several advantages over conventional waste treatment systems They include

- Recycling of plant nutrients
- Reuse of resources through crop production
- Retention of water in watersheds
- Recreation and open space
- Reduction of sludge

Land treatment can remove nutrients as efficiently as the best conventional processes, while achieving additional benefits The recovery and reuse of wastewater and nutrients through crop production is one advantage

Another is to keep water in a watershed In many conventional treatment systems it is common to discharge effluents miles from where waters are withdrawn and wastes are generated In water-sparse communities this water transfer is a problem because local groundwater is not replenished

Land treatment may also provide opportunities for recreation and open space to a greater extent than conventional systems All of these activities, as well as wastewater treatment and reclamation, allow land treatment systems to accomplish far more than most conventional treatment and discharge alternatives

Role of Advisory Groups

Citizen advisors can help assure that land treatment receives its deserved consideration. They can assist in the following ways:

- **Help pick suitable sites including those set aside for parks, open spaces, and green belt areas.**
- **Through meetings and other informal contacts, bring farmers into the planning.**
- **Promote the consideration of wastewater as a *resource* out of place, not a problem.**
- **Carefully scrutinize the analysis of land treatment to make sure that technical and management aspects have been adequately evaluated.**
- **Point out local problems and opportunities which the consultants may have trouble identifying.**
- **Seek assistance from the state water pollution control agencies and the EPA.**

This living filter at Muskegon provides advanced treatment for wastewater Organic matter is decomposed by soil microorganisms Nutrients are bound by plants and soil Suspended matter is filtered out by the soil Heavy metals, colored substances and viruses are adsorbed by organic matter and soil particles After percolation through the living filter, the renovated water is collected by a drainage system

Impetus for Land Treatment

Conventional wastewater treatment systems, especially those of a regional scope, are very expensive. Additionally, they are ill-suited to some localities.

In an effort to meet the needs of communities, and to stretch tax dollars, Congress passed two major water quality laws in the past decade. The Clean Water Act of 1972, PL 92-500, requires the United States Environmental Protection Agency (EPA) to encourage waste management that recycles nutrients in agriculture, forestry, and fish farming. The Clean Water Act of 1977, PL 95-217, reemphasizes recycling through innovative and alternative wastewater systems, including land treatment. This legislation authorizes monetary incentives. They include

- Making land used for wastewater storage and application eligible for grant assistance
- Allowing land treatment alternatives to receive funding even if they are 15 percent more costly than conventional treatment
- Supplying federal grants for 85 percent of the construction costs
- Allowing full modification or replacement if innovative or alternative projects fail to meet required water quality criteria.

In implementating the Congressional mandates, the EPA administers policies on land treatment. They include.

- Vigorous promotion of land treatment to reclaim and recycle municipal wastewaters
- Full justification when land treatment is rejected in facilities planning
- Exclusion from EPA funding those works designed for high levels of treatment before applying wastewater to the land.

Facility plans which give only cursory coverage to land treatment will be rejected as not fulfilling EPA requirements.

Land Application Techniques

Land application techniques consist of three categories:

- Slow-rate irrigation
- Overland flow
- Rapid infiltration (infiltration-percolation)

Wastewater is usually applied by spraying, flooding, or running between ridges and furrows.

Municipal wastewater, usually treated to some extent, is applied to land mainly by the irrigation and rapid-infiltration methods. Municipal installations currently are just beginning to use overland flow. Industrial wastewater, generally screened or settled, is applied using all three approaches, with the choice usually dependent on the type of soils

The water just does not disappear when it is placed on the soil. It becomes part of the water resources of the region! For this reason, the land-treated wastewater must meet the criteria established for the receiving waters. For example, permanent groundwater recharge must meet drinking water quality criteria, and surface runoff must meet surface water quality criteria

Treatment of Wastewater Prior to Land Application

Pretreatment requirements vary from state to state. Some are more demanding than others. The EPA asks that states modify stringent preapplication treatment requirements when a lesser level of treatment will still protect the public health, protect the quality of surface waters and groundwater, and ensure satisfactory performance of the wastewater management system.

States should adopt flexible criteria and standards for regulating land treatment systems. This flexibility conserves.

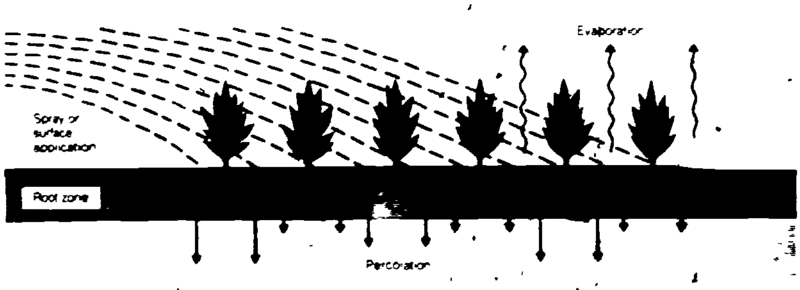
resources, and supports systems that are best suited for local conditions. For example, only simple screening or grinding may be appropriate for overland flow systems in isolated areas with no public access. However, extensive removal of organic pollutants followed by disinfection may be necessary for slow-rate systems in public areas such as parks or golf courses. Secondary wastewater treatment prior to land application should be held to a minimum.

Slow-Rate Irrigation

Irrigation is the most widely used type of land application. As many as 3,000 U.S. communities practice this approach. Factors controlling this type of land application are the site, the method of irrigation, the application rate, the management and cropping practices, and the expected pretreatment or removal of wastewater constituents.

The major factors involved in site selection are:

- Type, permeability, and depth of soil
- Nature, depth, and type of underground geological formation
- Soil surface topography
- Considerations of public access to the land.



Slow-Rate Irrigation

Soil drainage is perhaps the primary factor. Drainage is important because, coupled with the type of crop or vegetation, it directly affects the application rate for liquid. The ideal soil is moderately permeable. The agricultural extension service or neighboring farmers can be consulted about the drainage of cropland. University specialists can offer advice on forest or landscape irrigation.

For crop irrigation, slopes are generally limited to about ten percent or less, depending upon the type of farm equipment to be used. Heavily-foliated hillsides up to 30 percent in slope have been spray-irrigated successfully.

An ideal site for wastewater irrigation is in an area with limited contact between the public and the irrigation water. An obvious exception is the controlled irrigation of parks, golf courses, and other public use areas.

Irrigation Factors

The type of irrigation system depends on soil drainage, crop, topography, climate, and economics. These factors control the rates at which effluent substances can be removed by the soil.

Loading rates are important for water, nitrogen, heavy metals, and organic matter. A loading rate is the amount of water or pollutant placed on the soil in a certain length of time Organic loading rates are less significant if an intermittent application schedule is followed. Nitrogen loading rates are of concern because of nitrate passing down through the soil into the groundwater. If wastewater is applied at a proper rate, crops can absorb and utilize the nitrate, thus preventing it from entering the groundwater

System Life

Wastewater irrigation sites can have long, useful lives. For example, systems have been operating in Cheyenne, Wyoming, since 1881 and in Fresno, California, since 1891. Many other irrigation systems in the United States and throughout the world have equally long records of successful operation.

Irrigation has many positive effects on the environment, such as providing wildlife habitats when public access is properly managed. It is effective for recycling

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nutrients to the land. In general, irrigation is considered the most reliable approach to land application.

Economic Considerations

Capital costs for irrigation include those for land, and facilities for pretreatment, transmission, and distribution of effluent. The main operating and management costs are for labor, power, and system maintenance.

The economic benefits from irrigation can offset some of the operating expenses. In addition to the water, wastewater nutrients are an increasingly important contribution to crops. These nutrients replace synthetic fertilizers that become more expensive as energy costs increase. *In 1975, Muskegon County, Michigan, realized $714,000 from the sale of crops and services. These revenues helped to markedly reduce the gross operating costs of $1,946,000 for the land treatment system. Over four years of successful operation, the crop revenues have been approximately 30 percent of the annual operating and maintenance costs.* The Muskegon facility used publicly-owned land. For successful land treatment projects, land acquisition is not necessary in many cases.

Overland Flow

In overland flow the wastewater is applied to sloping land. The water runs downhill to a collection ditch. The crop or vegetation on the ground surface is not always harvested.

Overland flow has been used ~~for a long~~ time. The method has been tested on municipal wastewater, but in the United States it has been more completely developed for food processing industries. Several community systems are now under

Irrigation Site Analysis

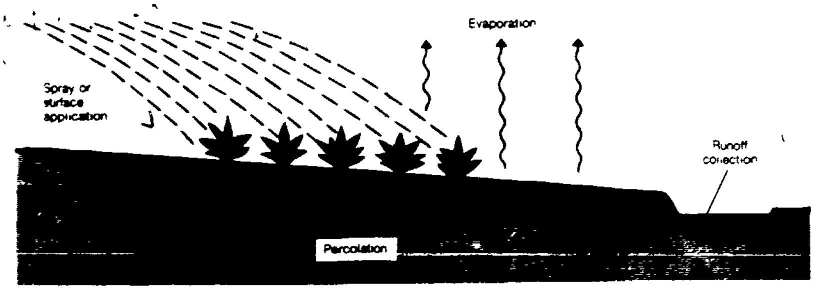
Factor	Criterion
Soil type	Loamy soils are preferable, but most soils from sands to clays are acceptable
Soil drainage class	Well-drained (more than 2 in./hr.) soil is preferred
Soil depth	Uniform depth of at least 5 to 6 ft. throughout the site is necessary
Depth to groundwater	More than 2 ft. is preferred at all times
Groundwater control	Drainage may be necessary to ensure performance if water table is seasonably shallow
Groundwater movement	Velocity and direction must be determined
Slopes	Up to 15% slopes are acceptable with or without terracing
Underground geological formations	Rock strata are analyzed for interference with groundwater or percolating water movement
Isolation	Moderate isolation from the public is preferable, the degree depending on level of preapplication treatment, method of application, crop, and site use
Distance from source of wastewater	Economics

design or construction in southern states. The important factors in overland flow are:

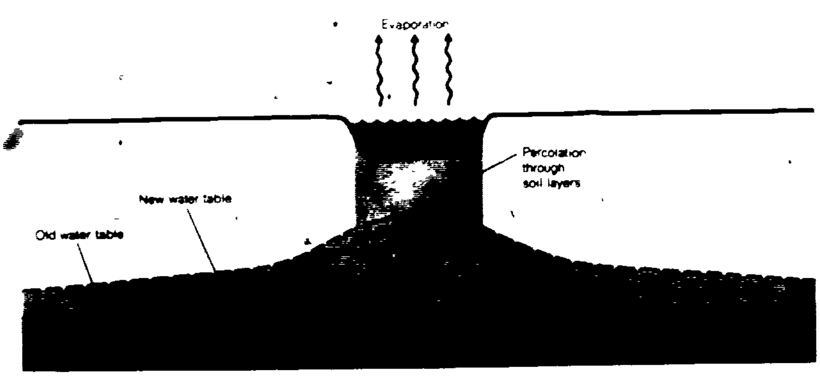
- Site selection
- Design loadings
- Management practices
- Type of pretreatment.

The runoff water collected and discharged into a stream has to meet the treatment and discharge criteria.

The treatment of wastewater by overland flow is less complete than for irrigation. Also, relatively less is known about the useful life of an overland flow system. In Melbourne, Australia, the treatment system has been operating successfully for many decades as a winter alternative to irrigation. The oldest operating systems in this country have been treating industrial wastewaters for up to 20 years. The literature suggests that a long useful life may be possible if effective management continues.



Overland Flow



Rapid Infiltration

Adverse environmental effects should be minimal. As the runoff flow occurs, it must be stored, reused, or discharged to a surface watercourse. Infiltration into the soil is slight and chances of affecting groundwater quality are low.

Overland flow facilities are very competitive with conventional methods where site and climatic conditions are favorable for year-round operation.

Rapid Infiltration

A third option is rapid infiltration. In this technique wastewater quickly moves through the soil until it becomes part of the groundwater.

Soils permitting the application of one to eight inches of water per day are best for successful use of rapid infiltration Acceptable soil types include sand, sandy loams, loamy sands, gravels, and gravelly sands Very coarse sand and gravel are less desirable because they allow wastewater to pass too rapidly through the first few feet, where the major biological and chemical actions take place.

Other factors of importance include:

- Percolation rates in the subsoils
- Depth, movement, and quality of groundwater
- Topography
- Underlying geological formations.

To control the wastewater after it infiltrates the surface and percolates through the topsoil, characteristics of the subsoil and groundwater layer must be known. Recharge should not be attempted without specific knowledge of the movement of water through the soils.

Wastewater treatment by rapid infiltration varies considerably with soil characteristics and management practices. This process is very effective for removal of suspended solids, organic substances, phosphorus, and metals. It is less effective for taking out nitrogen, although special management techniques have obtained nitrogen removals up to 80 percent. Overall nitrogen removal averages 30 percent for commonly used operating techniques.

The useful life of a rapid infiltration system may be shorter than irrigation or overland flow systems This situation is caused by high loadings of inorganic constituents, such as phosphorus and heavy metals, and by the attachment of these substances to the soil particles Therefore, the loading rate and soil characteristics are important in determining how long a site may be used Overall phosphorus removal is excellent for systems which have been operating about 35 years at moderate application rates of seven to fifteen inches per week. At Lake George, New York, phosphorus has saturated about fifteen feet of soil, but some percolation beds have an additional life span of 100 years because of the depth of sand still available for phosphorus removal.

From the standpoint of environmental effects, rapid infiltration is also a satisfactory method of wastewater treatment Many systems when managed properly are quite reliable.

Capital and operating costs for infiltration-percolation systems will generally be less than those for irrigation or overland flow because less land is used and distribution is by gravity flow For high-loading rate systems, however, prior needs and costs are substantially greater.

Other Land Application Techniques

There are several other approaches to land application, including

- Subsurface adsorption beds
- Deep-well injection
- Evaporation ponds

Such techniques are very limited in their applicability Adsorption beds are subsurface fields in which effluent seeps into the ground Usually limited to small flows, they are prevalent in rural areas as individual or cluster systems for disposal following septic tank treatment. Deep-well injection involves pumping wastewater to the groundwater table. It provides no substantial renovation to the wastewater, and is prohibited unless pretreatment is sufficiently high. Evaporation ponds also have limited use because they require large amounts of land, and cannot be used except in very dry climates.

Important Siting Factors

Advisory groups should pay close attention to the following points concerning the siting of land treatment systems.

Some of these points are:

- **Because land treatment requires land and land involves cost, land application systems may be too expensive for communities, especially when acreage is near a large city.**
- **High land costs favor conventional treatment systems, especially where large buffer areas are required around the application areas.**
- **Land treatment sites are not limited to municipal ownership. Public agencies and farmers can combine resources to create mutually beneficial systems based on leases or easements.**
- **A city may supply the pretreated wastewater to a holding pond. Through agreements with the city, farmers can withdraw the water and apply it to their lands.**
- **A city must maintain adequate operational and monitoring controls to protect water resources when utilizing lease or easement arrangements to supply water for the irrigation of private land.**
- **Regional differences in factors such as climate and availability of land are important.**

Cost-Effectiveness of Land Treatment

Today the issue of cost-effective wastewater treatment closely relates to system performance. The EPA now requires secondary treatment for all municipalities. Several consultants have made cost comparisons of land treatment versus other alternatives. These analyses show that land treatment is very competitive with conventional treatment under favorable site conditions. There are so many site specific variables that it is impractical to make many general projections about average costs for the slow-rate, rapid-infiltration, or overland flow processes. However, some generalizations can be made about the comparative costs of land treatment, conventional secondary treatment, and advanced waste treatment processes:

- Land application systems are less sensitive to the economics of scale, meaning that large facilities are not needed to achieve low costs as compared to conventional treatment processes.
- Under favorable conditions land treatment is more cost-effective than other treatment technologies for removing phosphorus, nitrogen, and suspended solids
- Under unfavorable conditions (cold climate or poor soil) land treatment becomes less competitive because of greatly increased capital costs for storage and land area. However, differences exist among the types of land treatment. While slow-rate systems are particularly vulnerable to these conditions, rapid infiltration systems are less susceptible.
- Because the costs of operation and management are lower for land treatment systems, the local share of total costs is much smaller than with advanced wastewater treatment facilities. Slow-rate systems usually recover a substantial fraction of the overall costs of treatment. These revenues come from the sale of crops or irrigation water.

Summary

The technology of land treatment systems is well-proven all over the world. The use of this technology often depends more on policy considerations than it does on technological ones.

Because land treatment processes contribute to the reclamation and recycling requirements of the Clean Water Act as well as conserve energy, they are defined as an alternative wastewater management technology. As such, land treatment proposals are eligible for a ten percent increase over the usual 75 percent federal grant. This 85 percent federal share, plus the potential for low long-term operations and management costs, may be particularly beneficial to smaller communities

While they are not accepted everywhere, land treatment systems have the potential for saving billions of dollars This will benefit not only the nationwide water pollution control program, but will also provide a way to recover and recycle wastewater as a resource

The EPA currently requires each applicant for construction grant funds to thoroughly analyze wastewater management alternatives, including land treatment.

Requiring stringent wastewater treatment prior to land application has quite often made land treatment processes too costly

The advisory group must be assured that appropriate federal, state, and local requirements and regulations are carried out, but not in a manner that arbitrarily blocks land treatment projects.

Given the strong and clear mandate of the Clean Water Act, an advisory group should expect that the consultant and grantee will give careful consideration to land application of wastewater. Advisory group members can help by locating suitable application sites, and by seeing that all appropriate factors are taken into account. If land application is feasible the advisory group can lead the way for public acceptance of this treatment method.

Because land treatment is often misunderstood, and sometimes causes local controversies, it may not be easy to develop. Public forums, presentations by experts from EPA and the states, field trips, and community workshops can help to foster reasoned and informed discussion of the issues.

Land Treatment Using Spray Irrigation

Muskegon County, Michigan

Adapted from Wastewater Is Muskegon County's Solution Your Solution" *EPA-905/2-76-004 MCD-34 Chicago, IL U S Environmental Protection Agency, Region V, August 1979, 55 pp*

Near the end of the 1960's, citizens, industry, and community leaders in Muskegon County were becoming aware of their overburdened wastewater treatment facilities The county's three main recreational lakes were being polluted Because of wastewater problems, older industries were leaving or closing rather than rebuilding. New industries and businesses were not coming to Muskegon

Muskegon County's Solution

Community leaders and planners in Muskegon County came to grips with the seriousness of the problems in 1969 Enormous political difficulties were involved in uniting the many independent communities within the county toward development of a common wastewater treatment system. Authorities, including the state and the Federal Water Quality Administration (a predecessor of EPA) had to be convinced that Muskegon's idea was worthy of funding and support. Large-scale projects using wastewater for spray irrigation and crop production in a northcentral location of the United States was an untested concept This made very difficult the task of designing and building a large spray irrigation system to provide efficient treatment while protecting the environment and enriching the quality of the soil

The Cost

Combined county, state, and federal efforts have resulted in a land treatment system which is yielding very cost-effective treatment and utilization of wastewater. Construction costs were approximately $44 million. Federal sources supplied approximately 45 percent of the funding

The 1978 total cost for treatment was 26¢/1,000 gallons of wastewater. This cost is charged to users via a 17¢/1,000 gallon operational fee, a 4.5¢/1,000 gallon debt retirement fee, and acreage charges. Muskegon County's sewer charge is lower than any of several systems surveyed, regardless of the level of treatment given to the wastewater

The Setting

Muskegon County, Michigan (population 160,000), which lies directly along the Lake Michigan coast, began its plan prior to Public Law 92-500.

The county-wide land application system has two separate wastewater treatment areas, a 10,500 acre site near Muskegon and a 600 acre site near Whitehall. Renovated water from the Whitehall site enters the White River and runs into White Lake and Lake Michigan. Renovated water from the main Muskegon site is collected by under-drains and discharged at two points One discharge enters Mosquito Creek and then flows into Muskegon Lake before entering Lake Michigan. The other discharge enters Big Black Creek which feeds Mona Lake before emptying into Lake Michigan.

The Main Muskegon System

The main Muskegon County Wastewater Management System has a 42 million gallons per day (mgd) wastewater treatment design capacity. The system consists of collection, transmission, aeration, storage, irrigation, soil, crop, and drainage components. The system treated 27 mgd of wastewater at startup in 1975, 60 percent of which was industrial flow, leaving a reserve capacity of 15 mgd for serving additional residential and industrial development.

Wastewater is collected via a conventional sewer system and pumped eleven miles to the land treatment site. After reaching the management site, wastewater is treated in aerated lagoons and then discharged to the large capacity (150 day retention time) storage lagoons. Prior to entering irrigation ditches the water is chlorinated to meet health standards.

The pretreated wastewater is distributed to irrigation rigs by buried pipes. There are 54 irrigation rigs located in circular fields of 35 to 140 acres. The soils are mostly sandy.

During the 1978 season, over 5,000 acres were planted with corn, and irrigated with wastewater up to 4 inches per week. Another 100 acres were in rye grass. Total wastewater applied to the 5,200 acres varied from none to

over 100 inches per field during 1978. Irrigation was performed from mid-April to mid-November with time out for cultivating, planting, and harvesting the corn crop. Thus far corn has been the main crop, and it has been marketed through normal channels.

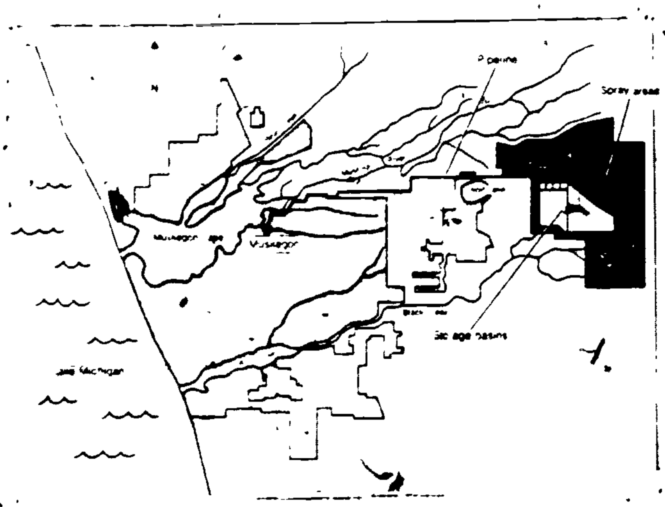
Recycling-Resource Recovery

The irrigation-soil-cropping phase of the wastewater treatment system provides advanced wastewater treatment, as well as utilizes nutrients in the wastewater for growing crops. The sale of corn reduced the 1.9 million dollar operating cost for wastewater treatment during 1978 by about one-third. *Over $120,000 worth of nitrogen, phosphorus, and potassium from the wastewater was reclaimed as fertilizer in 1978 to improve the soil and grow food* Additional chemical fertilizer was injected into the wastewater only during the active part of the growing season to increase corn growth and yield, and to stimulate increased removal of phosphorus, potassium, and other wastewater nutrients

Operations, Management, Research, and Development

The entire system is being operated by 40 full-time persons and an additional part-time labor force of 10 workers. The success of this operation depends heavily on expert management, which in turn is based on sound business, farming, engineering, and scientific skills Personnel also have laboratory analysis and research capabilities.

Management has benefited from the creation of a farm advisory board made up of agricultural agents from Michigan State University and from a research advisory board made up of EPA personnel As a direct result of good management, assisted by research and development



efforts, progressive improvements have been achieved and operational problems have been overcome at very modest cost.

Outlook and Life Expectancy

The Muskegon County Wastewater Management System has maintained its successful operation since 1974 by producing highly renovated wastewater while, at the same time, using wastewater and recycled nutrients to produce field corn. Pollutant removal has remained the same since start-up: 98 percent for BOD, suspended solids, and phosphorus; and about [illegible] percent removal of nitrogen Average yields on 5,000 acres of corn irrigated with wastewater increased from 60 bushels per acre in 1975 to 75 bushels per acre during 1976 to 1978. This yield has been consistently higher than the county average even though the primary purpose of the system is to renovate wastewater The income from sale of corn has continued to help offset operational costs such that the net operation and maintenance cost in 1978 (including debt retirement) was about 25¢ per thousand gallons of wastewater treated This is an increase of about 1¢ per thousand gallons over the 1975 figure

Increased Agricultural Productivity by Renovation/Reuse of Wastewater in Muskegon

	Corn Yield and Income				
	1974	*1975*	*1976*	*1977*	*1978*
			bu acre		
Wastewater site	28	60	81	73-75	73-75
County average	55	65	45-50	60	71
			millions of dollars		
Gross crop revenue	0 35	0 7	1 0	0 9	0 9

Finally, Muskegon is in the process of expanding its system Not only are additional residential and commercial areas in the county being connected, but there are increased flows from industrial expansion The county plans to add additional land, irrigation rigs, and other equipment for treating the anticipated increase in wastewater volume.

Any wastewater treatment system has limitations The Muskegon County Wastewater Management System is no exception In its present mode most of the cropped soils at Muskegon are expected to adequately remove wastewater contaminants like phosphorus for much longer than the design life of the project, at least 50 years If and when the land becomes saturated with phosphorus and can no longer provide adequate phosphorus removal, many other uses for the land will be possible Alternative uses such as energy production and recreation are being developed.

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Need More Information?

Guide to Clean Water Act Amendments. EPA No. OPA 129/8 Washington, DC: U.S. Government Printing Office, November 1978.

This publication contains many of the provisions of PL 92-500 (The Federal Water Pollution Control Act of 1972) and PL 95-217 (The Clean Water Act of 1977). It can be obtained from the U.S. Government Printing Office, Washington, DC 20402.

Hartman, Willis J., Jr. *An Evaluation of Land Treatment of Municipal Wastewater and Physical Siting of Facility Installations*. Washington, DC. U.S. Department of the Army. May 16, 1975 65 pp

This reported study and evaluation is directed toward providing some guidance to those who might select land treatment as an alternative process Particular emphasis is placed on siting facilities in more populated areas The report costs $8 00 and can be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The order number is ADA016118

Jewell, William J and Seabrook, Belford L. *A History of Land Application as a Treatment Alternative* EPA-430/9-79-012 MCD-40. Washington, DC U S Environmental Protection Agency, April 1979. 83 pp

This publication presents a complete history of land treatment technology including discussions of policy and a consideration of the future of land treatment This publication can be ordered from General Services Administration (8FSS) Centralized Mailing List Services, Bldg. 41, Denver Federal Center, Denver, CO 80225 Indicate the MCD number and title of publication.

Land Treatment of Municipal Wastewater Effluents Three Volumes Cincinnati, OH Technology Transfer Municipal Seminar Publications, 1979

These publications cover the various methods of wastewater treatment techniques on land including slow-rate irrigation, rapid infiltration, and overland flow It is a good set of reference manuals suitable for persons with limited knowledge but interested in land treatment They are available free from CERI, Technology Transfer, U S Environmental Protection Agency, Cincinnati, OH 45268 Specify order number 4010

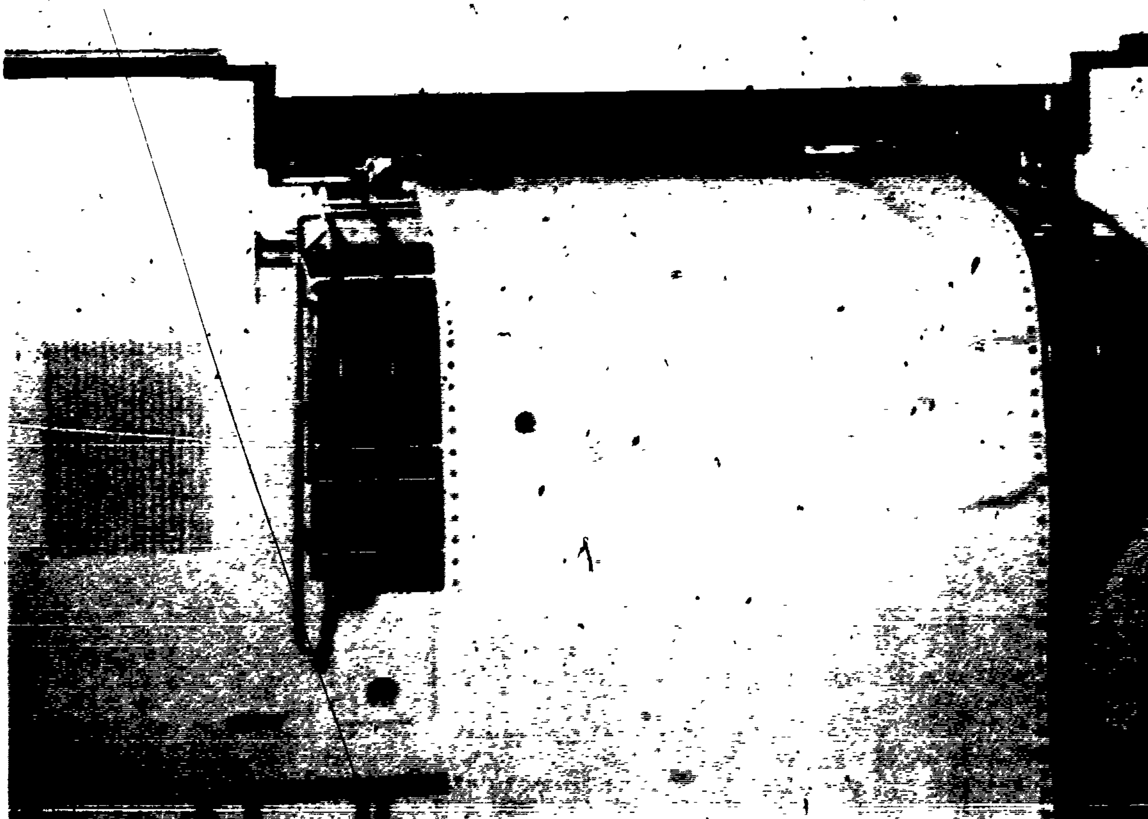
Pounds, Charles E , Crites, Ronald W and Smith, Robert G *Technical Report Costs-Effective Comparison of Land Application and Advanced Wastewater Treatment* EPA-430/9-75-016 MCD-17 Washington, DC U.S Environmental Protection Agency, November 1975 25 pp

This report is intended to be used for general cost comparisons of advanced wastewater treatment and land application systems. The curves shown in the figures are presented only for comparative purposes and should not be used to estimate costs of specific alternatives in facilities plans. This publication can be ordered from General Services Administration (8FSS) Centralized Mailing List Services, Bldg 41, Denver Federal Center, Denver, CO 80225. Indicate the MCD number and title of publication.

Survey of Facilities Using Land Application of Wastewater EPA-430/9-73-006. UNA-03 0. Washington, DC U.S. Environmental Protection Agency, July 1973. 377 pp

This report presents the results of a field survey of 100 facilities where domestic or industrial wastewater effluents were applied to the land. Ninety-nine tables and the collected data are presented along with photographs of representative facilities used to illustrate land application practices This publication can be ordered from General Services Administration (8FSS) Centralized Mailing List Services, Bldg 41, Denver Federal Center, Denver, CO 80225 Indicate the number and title of publication.

Assistance may be provided by the Land Treatment Coordinator in the Water Division of each EPA regional office



Chapter 10

Cost-Effectiveness Analysis

E Drannon Buskirk, Jr.

Costs In Water Quality Planning

It is ironic! Cost is a basic concern to many of us, but we are reluctant to learn its ins and outs We want to know the bottom line, but we don't want to be bothered with how it is figured Why? Perhaps it is because calculations are boring. More likely it is because costs are complex.

Indeed, assessing water quality costs is not easy There are both *monetary* costs, and *nonmonetary* factors such as environmental matters Direct and indirect expenditures are involved. These costs occur at different times—often years apart. Several alternative solutions to water quality problems are usually compared. All these considerations make cost assessment challenging, but not impossible. A way for making such evaluations is available. It is called *cost-effectiveness analysis*

Why Conduct Cost-Effectiveness Analysis?

Cost-effectiveness analysis permits the systematic comparison of waste-water management alternatives. The objectives of cost-effectiveness analysis are to:

- Maximize environmental enhancement per dollar invested
- Select the alternatives
- Provide a document for evaluation by the public
- Meet the requirements of the law.

Cost-effectiveness analysis documents the decision-making process. If done properly it should show that the taxpayer's monies have been used in the most efficient manner possible.

Section 212 of the Clean Water Act of 1977 requires that cost-effectiveness analysis be an important part of wastewater facility planning. The United States Environmental Protection Agency (EPA) will only fund projects determined to be cost-effective

Cost-effectiveness analysis should result in an integrated document bringing together answers to important questions about particular water quality problems. The environmental assessment, economic evaluation, and other considerations should not be evaluated in isolation. ***The key is to make sure that all factors are considered together*. By paying close attention and by asking questions, advisory groups can see that a comprehensive evaluation of alternatives is performed.**

Procedures For Cost-Effectiveness Analysis

The scope of cost-effectiveness analysis has changed over the years. Previously, monetary costs were compared against a single measure of effectiveness, such as the efficiency of treating wastewaters. Today cost-effectiveness analysis involves a broader range of considerations. In water quality planning these topics range from monetary costs and the reliability of systems, to environmental effects and the likelihood of implementing projects. Cost-effectiveness analysis has extreme breadth, but this breadth is necessary. Water quality projects are complex. A meaningful assessment must consider all factors

Controversy on the Pennypack

Wastewater management in the central Pennypack Creek area of suburban Philadelphia, Pennsylvania, has been a problem for years. Growth and the failure of many onsite sewage disposal systems have created pollution and public health hazards.

The Pennypack runs through communities totaling five million people. Two other sprawling cities, Trenton and Wilmington, are next door to Philadelphia. In this large metropolitan area there is a dwindling supply of open space and green acres. Three municipalities—Abington Township, Lower Moreland, and Bryn Athyn—have the only remaining green belt that is adjacent to Philadelphia. These communities are at the heart of the wastewater management controversy.

A private citizens group, the Pennypack Watershed Association, in the early 1970's recommended spray irrigation for the disposal of all wastewater in the central Pennypack area. The Association believed that land treatment would preserve existing open space, and enhance the feasibility of a proposed wilderness park and nature center.

In 1973, the Bryn Athyn Borough Authority applied for a federal grant to build a spray irrigation system. At about the same time the Abington Township Commissioners and the Lower Moreland Authority applied for funding to build a sewer on the Pennypack. This line would join an existing interceptor that leads to a Philadelphia wastewater treatment plant.

The United States Environmental Protection Agency (EPA), after preliminary review of the applications, decided that the proposals conflicted with one another. The EPA requested that the Pennsylvania Department of Environmental Resources (DER) take steps to resolve the problem.

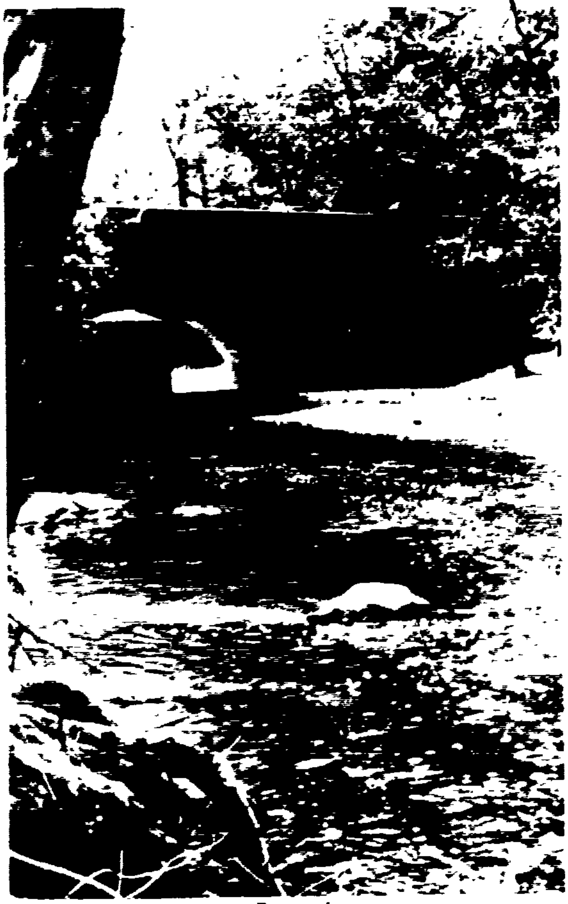
A consulting engineering firm was hired to evaluate the proposals. To increase local involvement, the DER formed the Pennypack Creek Watershed Task Force made up of the Pennypack Watershed Association, local municipal officials, and the staffs of planning and regulatory agencies.

Following completion of the consultant's report, a public meeting was held to obtain additional public input. Some municipal officials, dissatisfied with the findings, requested an independent evaluation. The DER agreed to another study by a different consultant.

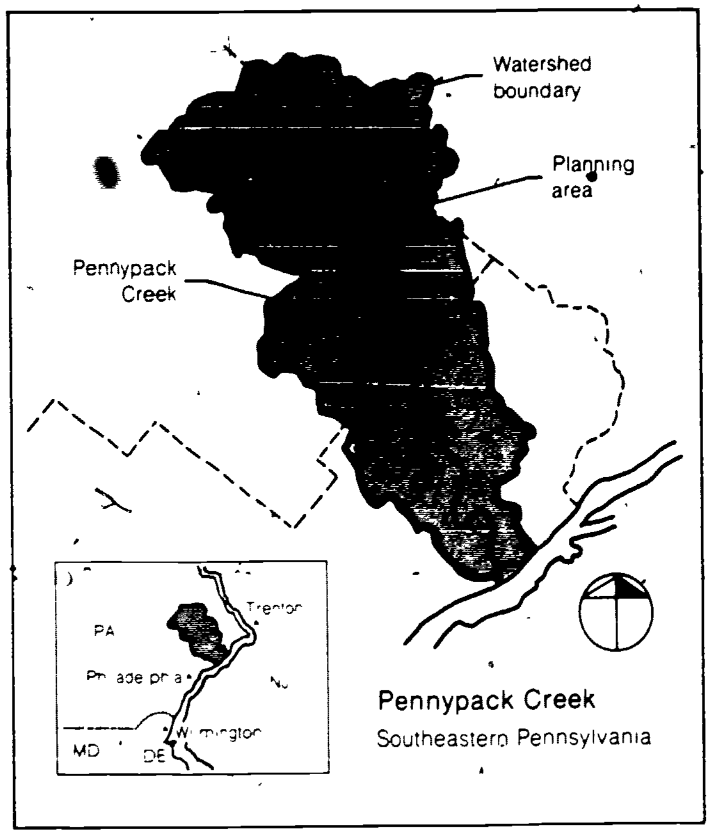
The DER next made an evaluation based upon its own studies, the two consulting reports, and comments from citizens and local officials. Three wastewater management alternatives—interceptor, spray irrigation, and a mixed interceptor/spray irrigation system—were assessed for cost-effectiveness.

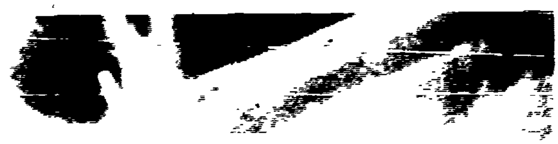
Two of the alternatives, the interceptor and spray irrigation options, are used to illustrate cost-effectiveness analysis.

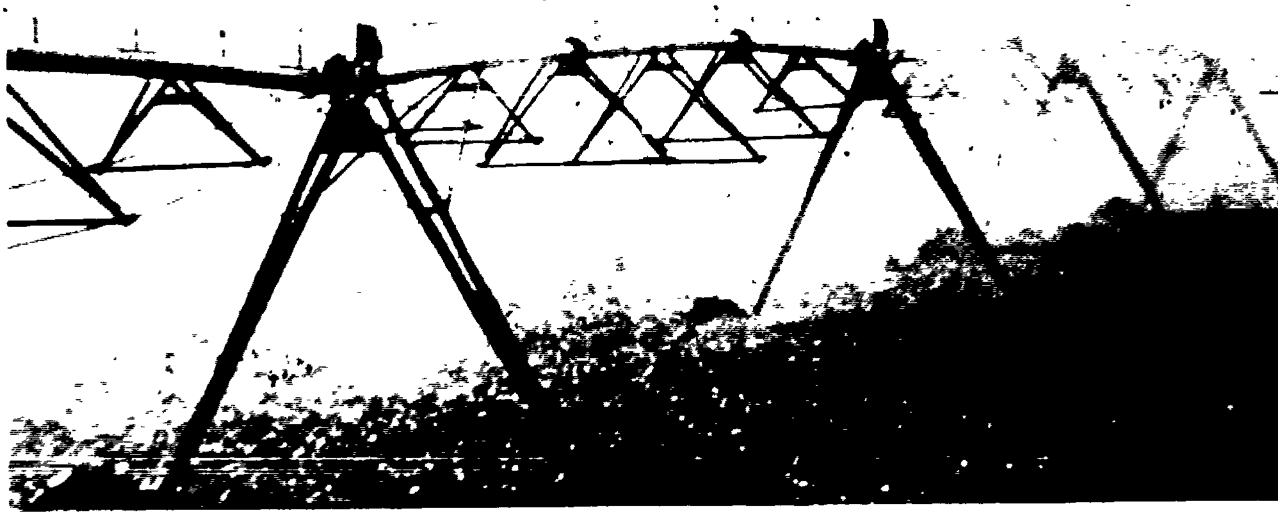
Adapted from *Conclusions Waste Water Management Study of the Central Pennypack* Publication Number 53. Harrisburg, PA. Bureau of Water Quality Management, Department of Environmental Resources. pp 78



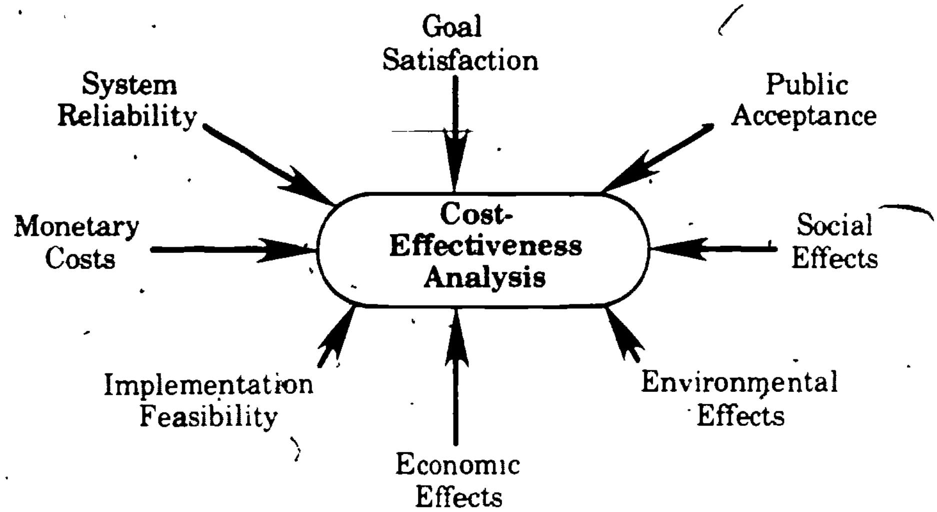
The Pennypack Creek in Pennsylvania







Spray irrigation alternative



Cost-effectiveness analysis encompasses the entire range of factors that go into making a decision

Everyone is interested in cost-effective solutions The term is heard more and more frequently at public meetings and presentations However, the term is often misused Real cost-effectiveness analysis requires specific calculations and procedures In water quality evaluation these calculations and procedures fit into the planning process

1 Determine the water resource problems
2 Define solution objectives
3 Develop feasible alternatives
4 Evaluate alternatives
5 Select plans

Cost-effectiveness analysis primarily involves the latter steps of the process, the evaluation of alternatives and plan selection However, certain preliminary analyses contribute to the cost-effectiveness studies

Preliminary Analyses

Determine Problems and Objectives

During the preliminary analyses, technicians estimate the present and future water supply and wastewater treatment needs When projections show wastewater production to exceed treatment capacity, and/or wastewater treatment is insufficient to meet water quality standards, the community has a problem

A wastewater facility usually has three parts the collection and transport of wastes, wastewater treatment, and the disposal of effluent and solids They may be analyzed separately, or may be so closely interrelated that they must be considered together In either situation it is necessary to state clearly the problems which must be addressed The advisory group should be assured that local problems, existing needs, and future problems are accurately identified and analyzed. Determining the extent of the existing situation is essential The rest of the planning is dependent upon it

Develop Alternatives

The number of alternatives selected for evaluation varies according to the nature, location, and scale of the project. All feasible waste management systems initially should be identified. These alternatives include

- Improved operation of existing facilities
- Conventional treatment processes
- Innovative and alternative technologies such as land treatment and wastewater reuse

The advisory group can play an important role in the initial screening of alternatives. As the alternatives are narrowed down, the advisory group can see that:

- **Alternatives to be considered are consistent with local values, facility planning regulations, and the problems and needs which have been verified**
- **Special attention is given to the size and location of sewer service areas, and the routing of interceptors.**

Other considerations include the size, type, and location of treatment works; flexibility for expansion in stages; and, if required, adaptability to multiple uses such as recreation.

Once the preliminary screening is complete, the community will be left with a small number of alternatives to be studied in detail. At this point the advisory group should feel confident that no viable alternatives were eliminated during the analyses.

Separate monetary and nonmonetary assessments are then performed on the alternatives. These evaluations are brought together by cost-effectiveness analysis. They provide the basis for selecting a plan.

On the Pennypack . . .

Preliminary Analyses

In preliminary studies of the Pennypack situation the following considerations were taken into account:

- Both the interceptor and spray irrigation options met the water quality criteria and standards for the watershed
- Population projections varied slightly between the consultants, but not enough to affect the wastewater flow estimates
- An interceptor built in a single stage was found to be more cost-effective than one constructed in several stages
- The legality of transferring wastes between governmental authorities (Philadelphia and the suburbs) was explored, but not settled
- The acreage for the spray irrigation sites and buffer zones was estimated at 452 acres. The consultants and the DER disagreed on the adequacy of soils for land treatment.

The subsequent study included site suitability and capacity, site availability, legality, monetary costs, environmental effects, social effects, mitigation costs, opportunity costs, financial costs, technical reliability, implementation feasibility, and public acceptability

Monetary Evaluation of Alternatives

Types of Costs

The monetary costs in constructing and operating a wastewater management system are crucial in cost-effectiveness analysis. For each alternative, various cost estimates should be obtained, including:

- Present and future capital costs
- Operation, management, and replacement costs during a 20-year period
- Mitigation costs
- Opportunity costs

Capital costs include land costs, acquisition of easements or rights of way, design, engineering services, field exploration, legal and administrative services, financing costs (e g , selling bonds), construction loan interest, start-up costs, and an appropriate allowance for contingencies Past capital costs, called sunk costs, must be omitted These expenditures have already been incurred They must be repaid regardless of which new alternative is adopted

Operation, management, and replacement costs are figured on an annual basis It is important to differentiate between annual costs that are constant over a project period, and those annual costs that vary with the pollution load carried by the system These costs should be separately estimated to avoid errors

Mitigation costs occur as a result of the steps taken to lessen the adverse impacts of alternatives Projects may need stream divergence, maintenance of stream flows, and other activities indirectly related to the alternatives. Such costs must be *reliable* to be considered monetary costs. Otherwise, there are significant adverse environmental impacts of a nonmonetary character. Care should be taken to report mitigation costs separate from other cost categories. Federal grants may not apply to the mitigation costs

Opportunity costs also are included in cost-effectiveness analysis. An opportunity cost is the monetary value of potential benefits lost as the result of a water quality action. It is not an out-of-the-pocket expenditure It represents an income that would have been received if the project were not done. For example, opportunity costs include the tax revenues or net recreational benefits lost as a project is developed. The value of land used for a treatment site, even if the land is already owned by the wastewater management agency, can be an opportunity cost. EPA guidelines call for the inclusion of opportunity costs, where reasonable, in determining overall system costs.

Cost-Effectiveness Requirements of The U.S. Environmental Protection Agency

Planning period for projects—20 years

Service lives for each component of a wastewater treatment system—

Land	Permanent
Structures	30 to 50 years
Process equipment	15 to 30 years
Auxiliary equipment	10 to 15 years

Interest or discount rate—set by the Water Resources Council, a federal water planning agency

Monetary costs—calculated as present worth values

Interest cost during construction—the interest rate "times" the total capital expenditures "times" half the construction period in years

Future inflation—usually is not considered in the analysis because constant dollars reflect real values of resources, not necessarily cash outlays.

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Cost Estimates

The costs of each alternative can be estimated by several means, including:

- Estimates by experienced local agencies and consulting firms
- Comparison with recent studies in the area or neighboring communities
- Previous project cost estimates adjusted for inflation and technological changes.

Some local agencies have the expertise, experience, and resources to estimate water supply and sewage treatment costs. Recent studies for the area or neighboring communities can give useful cost estimates If the cost estimates of previous projects are used, they must be updated to reflect local conditions and prevailing prices for labor, materials, and equipment

All costs must be based on the market prices at the time of the cost-effectiveness analysis No allowance is usually made for anticipated inflation It is assumed that the same inflation rates will apply equally to all the alternatives. An exception to this rule is made if it can be shown that the inflation will be abnormal for some components of a particular alternative.

Present Worth Analysis

The amounts and timing of monetary outlays will vary among the proposed alternatives It is essential to compare the outlays on a common basis *Present worth analysis* is used in making such cost comparisons

Present worth analysis is a method for bringing monetary costs or benefits to the same point in time Present worth is defined as

the present sum of money that must be placed on deposit at a given interest rate when the project construction begins (called the discount rate) to provide funds for the anticipated expenditures

It works like interest computations in reverse. A dollar invested today at ten percent per annum would be worth $1.10 in a year. A dollar a year from now, if discounted back at a ten percent rate today, would be worth about 90 cents. The same logic and procedures are followed in calculating water quality projects worth millions of dollars. All capital, operation, management, replacement, opportunity, and mitigation costs of each alternative over the first twenty years of its useful life are calculated. The estimated costs and monetary benefits at each point in time are discounted back to the present. The difference between these aggregated discounted costs, and the revenues from the sale of sludge and the salvage value of equipment and structures is the present worth for each alternative. The present worths of the different alternatives are then compared. *If overall costs, monetary and nonmonetary, are similar and the treatment efficiencies are comparable, the project with the lowest present worth must be selected in order to qualify for federal cost-sharing grants. Innovative or alternative technologies, such as land treatment, may have a 15 percent greater present value than competing alternatives, however, and still be considered the most cost-effective solution to a water quality problem*

Part of the cost-effectiveness analysis is based strictly upon items that can be reasonably expressed in terms of monetary costs However, this is only a piece of the picture. Other factors such as energy use, social effects, environmental impacts, and system reliability must be considered before an alternative can be chosen

Advisory groups can help the agency or consultant identify potential costs and benefits such as the sale of effluent fertilizers to include in the studies. Analysts sometimes overlook opportunity costs and situations that will need mitigation. A key role for the advisory group is to help point out such costs. In any case, advisory group members must not be put off by the complexity of the analyses. When in doubt, they should ask questions of those who conduct the analyses. Advisory group members should expect answers they can understand.

On the Pennypack . . .

Monetary Costs

The consultants did not agree on monetary costs. They differed especially on depreciation costs, mitigation costs, opportunity costs, and management fees. Considerable discussion centered on the calculations of the mitigation and opportunity costs. These estimates were criticized as being unrealistic. As resolved by the DER, the following cost estimates were made·

System Outlay Costs

- The spray irrigation had higher capital, operation, management, and replacement costs—about 1/3 higher than the interceptor option
- The costs of mitigating adverse effects on stream flows were much higher for the interceptor ($1.5 million vs. $300,000 for spray irrigation).

The total outlay costs were estimated at $13.7 million for spray irrigation and $12 million for the interceptor alternative.

Opportunity Costs

- Opportunity costs were very large for the interceptor—about $9 million for lost open space and recreation

Direct outlay costs thus favored the interceptor. This alternative was less expensive than spray irrigation—about $1.7 million or 14 percent less in system outlay costs. However, the inclusion of opportunity costs made the spray irrigation alternative much more attractive.

Different Perspectives

Cost-effectiveness is the main basis for EPA grants. Congress has mandated this requirement so that communities will receive maximum benefits for their dollars. Some important economic matters are not covered in cost-effectiveness analysis. For instance, communities want to know how they can pay their share of the costs. Citizens and local officials are especially concerned about funding sources, underestimated user costs, and costs that are ineligible for the EPA grants. Such matters are largely outside the scope of cost-effectiveness analysis. However, they remain important and must be dealt with during facility planning

Nonmonetary Evaluation of Alternatives

If economic costs were all that mattered, the selection of a water quality plan would be easy. The alternative with the lowest present worth would be chosen However, other considerations are just as important as economics These additional factors of project feasibility include·

- Environmental effects, including social considerations
- Reliability and flexibility
- Implementation capability
- Resource use and energy consumption
- Public acceptability

Environmental Effects

In the analysis of wastewater treatment alternatives, the environment is a key factor (The others are economics and system performance) The environmental assessment is a special part of facility plans, and is done concurrently with other studies in the planning process The assessment may lead to the preparation of an environmental impact statement if significant adverse effects are indicated for the water quality project

In the assessment an inventory of environmental conditions is compiled. This information provides a base against which predicted environmental changes due to the various alternatives may be evaluated.

Environmental Factors in Facilities Planning

Natural Resources	Cultural Features	Sensitive Areas
Water Quality and Quantity	Population	Endangered Species
Air Quality	Housing	Flood Plains
Climate	Transportation	Wetlands
Topography	Land Use	Coastal Zones
Geology and Soils	Economic and Social Profiles	Wild and Scenic Rivers
Plant and Animal Communities	Archaeological Resources	Agricultural Areas
Noise and Odor	Historical Areas	Earthquake Zones
Solid Waste	Recreation and Open Space	Steep Slopes
Energy Resources	Aesthetics	

The assessment reveals both *primary* and *secondary* environmental effects. Primary effects relate to the location, construction, and operation of the project. Primary beneficial effects include the elimination of pollution or public health problems, and the maintenance of groundwaters recharged by land treatment. Primary negative effects may involve soil erosion along sewer lines, noise, odors, loss of open space, and air pollution from incinerated sludge. Secondary effects are the indirect changes that are induced by a project. These impacts include changes in population, economic growth, and land use such as development around sewer interceptors **Advisory groups can be especially helpful in anticipating adverse social impacts, including the disruption of neighborhoods, inequities suffered by particular groups, and aesthetic problems.**

Adverse environmental and social effects, of course, can be a major factor in rejecting alternatives.

Reliability and Flexibility

A reliable system is one that meets its design efficiency with the anticipated effort, and operation and management costs. The main features of system reliability are

- Frequency of plant upsets or spills
- Need for operator attention
- Effects and frequency of sewer overflows

Flexibility concerns the capability for change—to expand the size of the treatment system, extend service to needed areas, upgrade the level of pollutant removal, and switch to wastewater reclamation and reuse or other options

Implementation Capability

A wastewater management system has the greatest chance of being carried out if it meets all legal requirements, is adequately financed and staffed, and is approved by all governmental units. If existing institutions cannot carry out the plan, the necessary arrangements must be made to create a new agency. This new organization, often called an authority, should be fully empowered to finance, operate, and manage a proposed project The key implementation factors include.

- Local political situation
- Amount of local funding and capability of community financing
- Personnel
- Prevailing state and local laws on public health, water rights, water supply, and land uses.

On the Pennypack . . .

Environmental and Social Changes

Spray irrigation is much more advantageous than the interceptor alternative when environmental effects are considered. The spray irrigation alternative should:

- Retain renovated wastewater in the basin and increase stream flows. The interceptor should reduce the flows
- Slightly improve the kinds and amounts of aquatic organisms in the tributaries. The interceptor will require impact mitigation
- Stimulate less development than with the interceptor, and thus disturb fewer wildlife habitats
- Make feasible open space and a wilderness park of an estimated present value of $9 million.

Except for the open space and recreational benefits of spray irrigation, only minor differences in social effects exist among the alternatives. The spray alternative may be more growth-limiting, depending upon treatment system capacity and future zoning.

Resource Use and Energy Consumption

Resource use and energy consumption in facility planning are becoming more and more important. The main resources in wastewater treatment facilities are energy, (electric power and fuels), chemicals, and land. The increased operational costs of these resources have reduced the cost-effectiveness of conventional alternatives such as physical-chemical wastewater treatment systems.

Public Acceptance

A wastewater system, even if it is properly designed and constructed, functions only as well as the community wishes. Like any project, if a water quality program is to succeed, in the long run it must be acceptable to the people. *The easiest way to achieve acceptance is for citizens to feel that they have a say in the planning and decision-making process*

An advisory group should be acutely aware of local concerns, conditions, and values. However, it cannot represent the ideas, priorities, and values of all the people. For this reason an advisory group should assist in developing a public participation program that reaches all elements in the community.

The evaluation of all monetary and nonmonetary factors of a project may reveal adverse environmental impacts that will have to be mitigated (avoided or corrected).

Overflowing interceptor sewer.

Mitigation of Potential Problems

The construction of sewage treatment facilities can cause primary and secondary impacts. These impacts can be either positive or negative. Some negative impacts are inevitable, but most can be avoided or mitigated if recognized early enough in the facilities planning process. Federal law requires grant applicants to identify negative impacts and make efforts to correct them

Mitigation Techniques

Primary impacts such as erosion, odor, and noise are generally short-term impacts. They are relatively easy to mitigate through

- Thoughtful planning
- Control of construction activities
- Operating procedures

Problems such as erosion and noise can be avoided, in part, through thoughtful site selection and suitable facility designs For example, noise can be kept down with earth berms or vegetative buffer strips. Construction impacts such as erosion and dust can also be controlled by construction activity schedules, the immediate restoration of disturbed areas, and periodic wetting of exposed soils. Another mitigating approach involves proper operating procedures such as the treatment and disposal of sludge to minimize odor

Secondary impacts tend to have long-term consequences that often are difficult to predict and correct. Efforts to control them are relatively recent. Little documented evidence shows how effective these measures can be in the long run.

The EPA has identified a range of possibilities for mitigating secondary impacts The list includes.

- Project changes (e.g , reduction in plant capacity)
- Phasing of sewer service
- Sewer use restrictions
- Planning coordination among communities
- Land management controls to protect water quality (e.g , zoning)

On the Pennypack . . .

Implementation, Reliability, Resource Use and Public Acceptability

The spray irrigation alternative has a slight advantage with regard to implementation. The legal and scheduling issues involving sewer connection to the Philadelphia wastewater management system remain unresolved.

The interceptor may be more technically reliable System upsets, spills, and maintenance requirements are considered greater for the spray irrigation alternative

Spray irrigation uses less chemicals, but much greater commitments of land and energy resources as compared to the interceptor alternative

Public sentiment has not shown a preference for other alternatives. The overall public opinion seems to be about equally split

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Implementation of Mitigation Plan

In most cases, a mitigation plan will work only if a community sees the need For example, if land use controls are used to lessen the growth impacts of a project, these controls must be supported by citizens and local officials. If existing 208 water quality plans or local land use plans are already in effect, it may be relatively easy to manage the secondary effects of wastewater projects simply by enforcing existing ordinances.

Timing is crucial for impact mitigation Adverse effects and mitigation measures should be determined early in the planning process. Once considerable time and money have been invested in a project, it becomes increasingly difficult and expensive to make changes.

Another important consideration is the implementation cost to the community Some mitigating measures, such as reduction in facility size or service area, may actually decrease project costs. Others, such as siting the facility so as to use prevailing winds for the natural control of odors, may have little or no effect on costs Still, other mitigating measures may increase the project cost, or may not be eligible for federal construction grant funding.

If mitigation costs are required for an alternative, they must be included in the cost-effectiveness analysis

It is important for advisory groups to see that these factors are discussed fully during facility planning. Professional planners often are reluctant to delve into subjective matters. Advisory group members have a responsibility to see that a full discussion, subjective or objective, takes place.

Display of Costs and Effects

All significant costs and effects of each alternative must be clearly displayed in the cost-effectiveness analysis All people who participate should be able to compare the proposals and their tradeoffs. The cost-effectiveness analysis must be an integral part of the facility plan

Costs and effects can be displayed in various formats An approach suggested by the EPA is an accounts sheet This technique is basically a table Categories of factors are listed in a column The effects of every alternative are placed next to the factors Such an arrangement permits easy comparison of information The technique has drawbacks, however. The total or composite effect of the alternatives is not easily perceived Interrelationships are not apparent **The advisory group can help fill this gap by making sure that all effects are considered in evaluating the proposed alternatives.**

Plan Selection

The main purpose of facility planning is to select the plan best suited to a community's water quality goals at the least cost to the community. Through the comparison of proposals, cost-effectiveness analysis provides the basis for this decision Despite the apparent complexity of the calculations, there is no rigorous analytical method of choosing the most cost-effective alternative Environmental, social, and resource costs are not measured in the same ways. Other factors—public acceptance, reliability, and implementation—influence the choice of a plan Also, individual perceptions of relative values vary widely

On the Pennypack . . .

Cost-Effectiveness Matrix

Criterion	Alternative: *Interceptor*	Alternative: *Spray Irrigation*
1. Water Quality Goals		
A Contribution to Goals and Policies of Federal and State Pollution Control Laws	Fair	Excellent
B Contribution to other Water-Related Goals of the Planning Area		
1 State	Poor-Fair	Good-Excellent
2 Local	Poor-Fair	Excellent
2. Technical Reliability		
A Frequency of Plant Upsets	Infrequent	Infrequent
B Frequency of Spills	Infrequent	Infrequent
C Frequency and Effects of Combined Sewer Overflows	Slight increase	N A
D Nonpoint Source Control	N A	N A
3. Monetary Costs		
A System Outlay Costs		
1 Capital Costs including discounted deferred costs	$ 8,162,626	$ 9,191,912
B Lost Opportunity Costs		
1 Open Space Recreation	$ 9,857,000	
2 Pennypack Streamflow Loss not Mitigated (215 days yr)	$ 2,198,846	
TOTAL - Lost Opportunity Costs	$12,055,846	
4. Financial Costs ($ Equivalent Dwelling Unit/yr for System Outlay Costs)		
1 With Present EPA Funding Policy	$ 149	$ 129
2. With EPA Funding Mitigation and Leasehold Costs	$ 141	$ 123

5. Environmental Effects	Interceptor: *Direct*	Interceptor: *Indirect*	Spray Irrigation: *Direct*	Spray Irrigation: *Indirect*
A Hydrology (surface and groundwater)				
1 Water Quality				
a Dissolved oxygen	Meets standards	N/A	Meets standards	N A
b Phosphate	Impacts mitigated	N/A	Slight decrease	N/A
c Tributary streams aquatic life	Impacts mitigated	N/A	Slight improvement	N/A
2 Water Quantity	Reduces by 1 74 cfs or 16 2%	N/A	Increases by 1 58 cfs or 14 7%	N/A

N A Not applicable

Cost-Effectiveness Matrix (Continued)

3 Flood Hazard	N/A	Need for stringent controls	N/A	Need for stringent controls for
B Biology				
1 Rare and Endangered Species	. . . . One specie reported Impact unknown			
2 Wildlife Habitats	Temporary impact	Shift in wildlife composition in new development areas, 450 acres more then spray irrigation	Spray fields may result in changes in wildlife habitats	Shift in wildlife composition in new development areas
C Air Quality	Not significant	Minor	Not significant	Minor
D Land				
1 Amount of Growth (people 1970-2020)	N A	8,395	N A	5,395
2 Type of Growth	N A	Current zoning	N A	Current zoning except master plan development area

6. Social and Economic Changes				
A Changes in Economic Activity				
1 Agriculture	N A	N A	200 acres	N A
2 Land Value	Impact on land values unknown			
B Employment Changes				
1 Regional Availability of Skilled Manpower for Treatment Plant O & M	Sufficient	N A	Sufficient	N A
2 Dislocation	N A	N A	N A	N A
C Public Health	No significant impacts with adequate treatment Both beneficial in removing failing septic systems			
D Aesthetics				
1 Recreational Accessibility and Activities	None	Possible loss of wilderness park	None	None
2 Unique Archeological Historical, Scientific, and Cultural Areas	N A	N A	N A	N A
3 Noise Pollution	Not significant	Not significant	Slight potential from localized noise from aerated lagoons and spray nozzles	Not significant
E Other	N A	N A	Potential to demonstrate watershed management	N A
7 Implementation Feasibility and Reliability				
A Legal Capability	Slightly more potential impediments		Slightly less potential impediments	
B Operational Effectiveness	No significant difference			
C Practicability	No significant difference			
D Coordinative Capacity	No significant difference			
E Public Accountability		N A		N A
8 Public Acceptability				

Main Points

Cost-effectiveness analysis permits the systematic comparison of wastewater management alternatives The costs of using different methods to achieve similar goals are compared.

The analysis should result in full documentation of both monetary and nonmonetary factors—a display that clearly shows the tradeoffs among the alternatives

The main components for cost-effectiveness analysis are *monetary* costs, *nonmonetary* factors such as environmental and social costs, and *implementation* considerations such as system reliability

Cost-effectiveness analysis is part of a five-step planning sequence It is most useful in the latter steps of the process—the evaluation of alternatives and the selection of a plan

Costs and benefits of several alternatives are compared at the same point in time through *present worth analysis.*

The cost-effectiveness analysis determines what is eligible for EPA construction grants.

Advisory groups have important roles in assisting their agency decision makers. These functions include:

- **Identifying feasible alternatives that are consistent with local values**
- **Verifying problems and needs**
- **Identifying relevant benefits and costs, especially opportunity and mitigation costs**
- **Seeing that various tradeoffs are identified and discussed in the community**
- **Assuring that the composite or total effects of alternatives are evaluated**
- **Helping to carry out a community involvement program.**

Selected Resources

Need More Information?

Construction Grants Program Municipal Wastewater Treatment Works Rules and Regulations Appendix A Cost-Effectiveness Analysis *Federal Register* Volume 43, Number 188 September 27, 1978

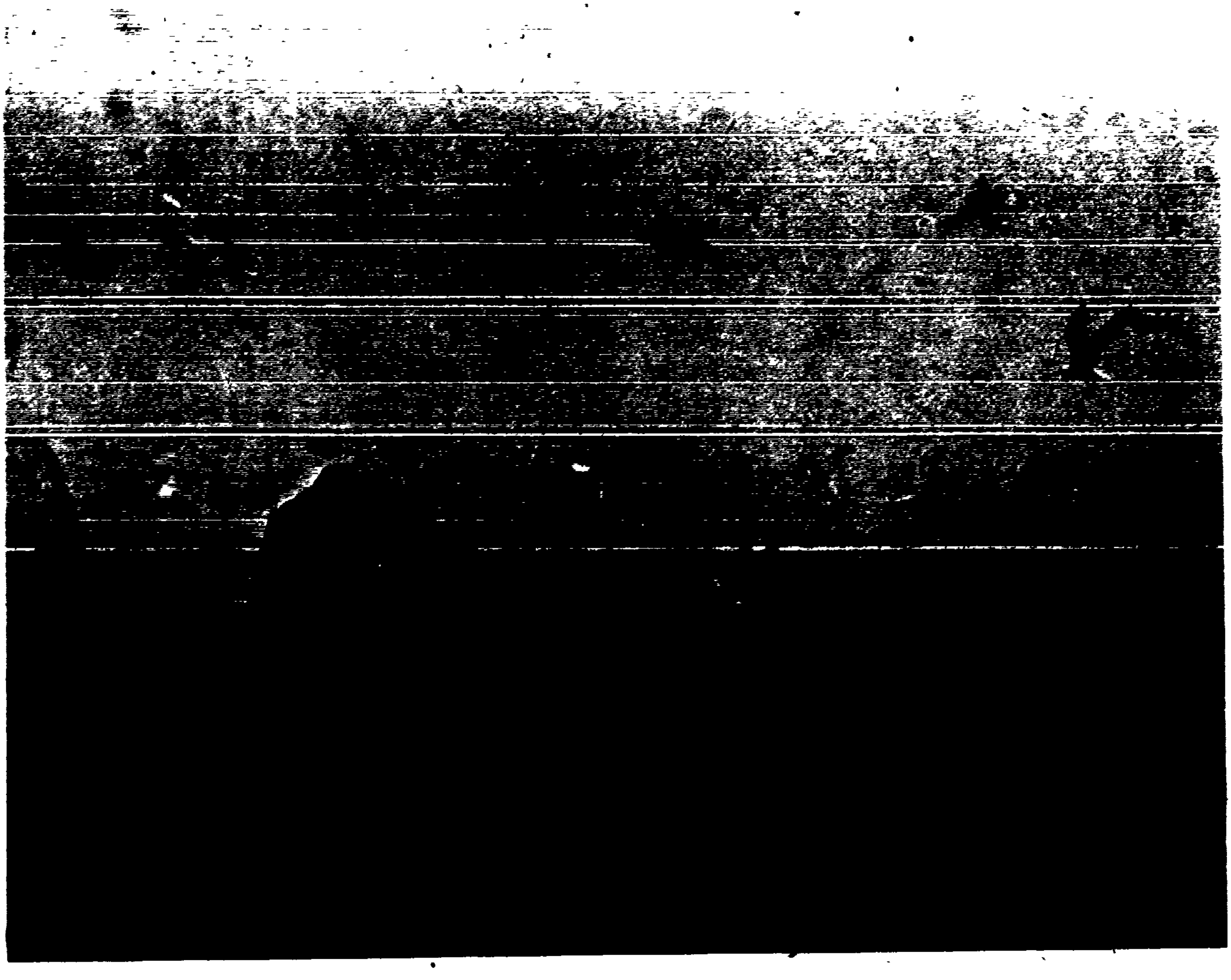
This is the most up-to-date set of EPA regulations based upon the Clean Water Act of 1977 It gives a detailed discussion of cost-effectiveness analysis procedures

Guidance for Preparing a Facility Plan EPA-430/9-76-015 Washington, DC Office of Water Program Operations, Municipal Construction Division, U.S. Environmental Protection Agency, May 1975 32 pp. with references and appendices

This publication briefly discusses the facility planning process Featured are considerations at each planning step (e.g., cost-effectiveness analysis), the format for plan submissions, and the relationship of facility plans to other water management and planning programs. More detailed instructions are given in the January 1974 version of the same document. This publication can be ordered free of charge from General Services Administration (8FFS), Centralized Mailing Lists Service, Building 41, Denver Federal Center, Denver, CO 80225 Be sure to mention the publication title and the number

Schmidt, C.J and E E. Ross. *Cost-Effectiveness Analysis of Municipal Wastewater Reuse* WPD-4-76-01. Washington, DC Water Planning Division, U.S Environmental Protection Agency, April 1975 116 pp with 5 appendices.

Although this book pertains specifically to alternatives which reuse wastewater, it contains a chapter on cost-effectiveness analysis. This section gives the basic procedures for the technique, the EPA cost-effectiveness guidelines, and formats for present worth calculations This publication can be ordered free of charge from Library Services, Maildrop 35, U S Environmental Protection Agency, Research Triangle Park, NC 27711 The publication number is 5725



Chapter 11

Environmental Assessment

E. Drannon Buskirk, Jr.

Focus on Environment

In many parts of the country, surface waters are cleaner today than they were just a decade ago Fish are returning to once-polluted streams Community pride in water resources is on the upswing Although the work for clean water is far from over, things are better in many places All this was accomplished while population grew, and pollution continued What turned the situation around? It is mainly a matter of environmental awareness, and careful consideration of the environmental effects of plans

What is meant by environment? How is it involved in planning? Where do citizens fit in?

Environment is a word of many meanings. For the interior decorator it means household furnishings. To urban dwellers it includes skyscrapers For some persons it is the natural world of plants and animals These diverse viewpoints have one thing in common—surroundings. *Environment means surroundings* In water resource planning, environment includes natural elements such as water and wildlife, and economic and social features such as employment and housing Meaningful water resource planning thus involves just about everything Economic matters alone are not enough

Including environmental considerations in water resource planning has several benefits

- Incorporation of environmental values in decisions
- Protection of cultural, historical, and natural resources
- Broad basis for determining the costs and tradeoffs of proposed projects

Besides, it is the law!

Regulations of the United States Environmental Protection Agency (EPA) call for the consideration of the environmental effects of certain projects and programs in water resource planning These regulations apply to efforts such as 201 local facilities plans, and 208 water quality management plans (The numbers refer to sections of the Clean Water Act)

Facility Planning

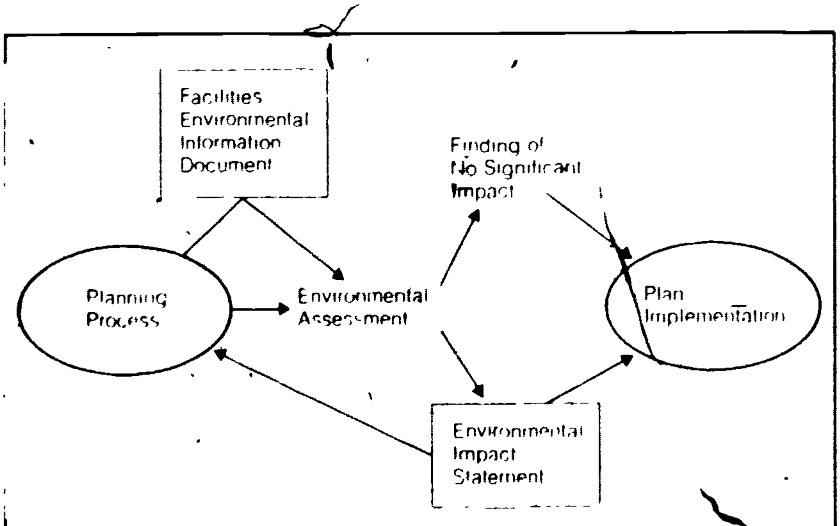
In planning local wastewater management facilities, an *environmental information document* describing the environmental effects of proposed actions is prepared by the grantee or similar agency The EPA then evaluates this information for environmental impacts, and ways of avoiding or minimizing the adverse effects of the actions. The resulting public document, called an *environmental assessment*, provides data and analyses on the significance of the environmental impacts. If no significant adverse impacts are anticipated, the EPA issues a *Finding of No Significant Impact.* However, if significant impacts are possible, and they cannot be sufficiently reduced or eliminated, an *environmental impact statement* is prepared and released. The impact statement is a report which identifies and analyzes in detail the environmental impacts of proposed actions and feasible alternatives. The statement differs from the environmental assessment in the level of detail and in the scope of analysis; it is more comprehensive than an environmental assessment, and concentrates upon areas with potential for significant environmental degradation Impact statements are prepared when the wastewater facilities will induce significant changes in land uses, will seriously impair air or water quality, or will adversely affect other resources.

An overwhelming majority of the assessments report no significant adverse impacts. Fewer than ten percent of the facility plans result in impact statements. Increasingly, however, the EPA and/or the public have been challenging the environmental findings because of inadequate analysis, or the insufficient documentation of community needs. These controversies can delay facility planning for a year or more. In several regions such as New England, some impact statements are prepared concurrently with the facility plans. While the impact statement must be complete before the facility plan can be approved, this "piggybacking" approach can avoid the delay inherent in doing the two separately.

Water Quality Management Planning

In water quality management (WQM) planning, environmental information also is used in shaping alternatives However, a separate report such as the environmental information document is not prepared during or after the WQM plan is completed The environmental information is included with the plan itself The final form of this data is determined by the state or areawide planning agency, and the EPA regional office

After the plan is submitted, the EPA reviews the environmental findings to determine whether an impact statement is necessary If a significant adverse environmental impact is likely to occur, a draft statement is prepared by the EPA, and is distributed to interested or affected groups. After these recipients have had time to comment, a final statement is prepared incorporating their comments State and areawide water quality management plans seldom need environmental impact statements



Elements of Environmental Assessment

Although the environmental information of WQM and facility plans may be reported differently, the contents are essentially the same. Together with a list of information sources, the environmental information includes:

- Description of current and future environment, without the implementation of a plan
- Evaluation of alternative plans
- Discussion of environmental consequences
- Description of measures to mitigate or minimize adverse effects

These aspects, in general, apply to both WQM and facilities planning

Description of Current Environment

Knowledge of the existing environment is important for identifying water quality problems and for comparing alternative plans In describing the current situation, analysts look at natural resources such as water quality, cultural features such as population, and environmentally-sensitive areas such as wetlands However, this is not just a straightforward data-gathering exercise. Environmental information missed or misinterpreted may substantially affect the planning outcome

Advisory groups can monitor the current situation by seeking answers to questions such as:

- **Have the environmental aspects of existing water quality problems, from both point and nonpoint sources, been sufficiently and accurately identified?**
- **Are existing population and land use data properly assessed?**
- **Have all environmentally-sensitive areas been identified?**
- **Are the boundaries and criteria of the analysis realistic?**
- **Do the methods of data collection make sense?**

A basic concern is the accuracy and scope of the data. Careful attention to study boundaries and assessment criteria can minimize these difficulties.

Study Boundaries

Boundaries refer both to the geographical area, and the type and degree of topics that make up the studies The geographical area must be large enough to assess all potential environmental impacts of any wastewater treatment alternatives or water quality management plans. It must, for example, include the entire area that might receive growth induced by water projects Similarly, it must be large enough so that cost-effective alternatives can be considered. Since boundary selection often crosses town borders, especially in WQM planning, political and legal tugs-of-war may occur among communities This conflict can be held to a minimum by the selection of advisory group members who represent the relevant interests of participating communities

Another type of planning boundary is the subject matter or scope of studies Although the EPA regulations call for certain analyses such as population projections, other factors not explicitly named should be studied. For example, in some areas the ethnic composition and location of the residents may be just as important as overall population size

Since the advisory group is especially sensitive to local concerns and values, its perspectives can be invaluable in setting the course of these planning studies.

Assessment Criteria

Criteria, the guidelines for making decisions, need explicit attention in environmental studies. The use of *appropriate* criteria throughout the planning process — from data collection to plan selection — is extremely important Some criteria, such as those for cost-effectiveness analysis, are given in the regulations However, others such as those for data collection are not drawn out. Sometimes, in a rush to get the work done, poor data measures are adopted and/or the reasons for their selection are not given A remedy for this situation is having measures that fit the subjects For example, quantitative measures are often inappropriate for assessing aesthetics. Yet, some analysts compare all factors, including aesthetics, on a numerical basis

It is neither the role nor the function of advisory groups to make such analyses. This work is best left to the consultants and planning staff. However, advisory groups have a responsibility to know how data is being collected, analyzed, and interpreted. They should be told why certain assessment approaches were chosen, why others were ruled out, and what ramifications these choices have for the community. Since all planning is based upon data, advisory groups must see that the methods of data collection make sense.

Description of Future Environment

Many WQM and facility plans propose reasonable solutions to managing water quality and disposing of wastewater However, some plans have resulted in economically and socially burdensome projects A major shortcoming has been the identification of water quality and wastewater management needs, especially future needs This aspect of environmental analysis, the determination of the future situation both with and without plans, is a weakness of the assessment process

Compared to the effort spent compiling an inventory of the present situation, too little attention is often given to future conditions. Projection methods may be inadequate For example, an environmental assessment of a proposed wastewater project in central Pennsylvania stated that sewer construction alongside a trout stream would result in sedimentation No estimates were given of the amount of sedimentation or its effects on fish, water quality, and aquatic productivity In this instance, the description of the future environment was clearly inadequate However, the extent of these studies depends, in part, upon the anticipated impacts and their value to the community Every aspect cannot be studied to the last degree Just as decisions must be made on the scope of studies, similar decisions must be reached on the extent of the assessments

Testing water quality

Advisory groups, sensitive to community concerns, can help decision makers make judgments about the resources that are committed to an environmental assessment. Factors that are complex or important usually will need more effort spent on the assessment. One factor in water quality planning that is particularly significant is the size of the future population.

Population Estimates

Most water quality difficulties are caused by human actions Many problems such as urban runoff and wastewater production are often in direct proportion to the number of people. Therefore, accurate population estimates are essential in assessing the future situation

To avoid unneeded wastewater treatment capacity, or construction that induces undesired growth, the EPA has guidelines for making population estimates The EPA requires that population estimates for each facility planning area be consistent with the national and state estimates The state water quality agency, working with WQM planning agencies or other regional agencies, will break down the state population estimates into regional projections Numerous facility plans may fit into these projections

Maine A 208 water quality analysis and population projection identified eutrophication from phosphorus enrichment as a potential threat to Lake Maranacook, which borders Readfield Agriculture, failing septic systems, and stormwater runoff were found to be the sources of this nonpoint source pollution

Various analysis approaches at the local level may be used, including extrapolations of past growth trends, estimations according to population age groups, and even forecasts based upon business activities However, the approach that is adopted must make sense. Its results must be consistent with the overall estimates for the state and water quality planning area Any deviance from these projections, as might occur from an unanticipated influx of immigrants, must be thoroughly justified by the planning agency

A few questions appropriate for describing the future environment include:

- **Can current and past trends be expected to continue into the future?**
- **Are the projections of population, stormwater runoff, and similar considerations realistic?**
- **Are any potentially significant factors excluded from the assessment?**
- **Have sufficient resources been allocated for studying important issues?**

These descriptions of current and future environments provide a basis for evaluating water quality and wastewater management alternatives

Evaluation of Alternatives

The environmental assessment is used for comparing alternatives, and selecting the final plan. An array of possibilities is usually considered Alternatives are screened based upon monetary costs, environmental effects, and physical, legal, or institutional constraints Alternative actions include structural approaches such as wastewater treatment plants, and sediment basins for stormwater runoff, nonstructural measures such as land use ordinances, and changed operation and management for improved wastewater treatment efficiency In fact, the EPA regulations for facility planning call for analyses involving

- Flow and waste reduction measures through water conservation and control of infiltration/inflow
- Alternative locations, capacities, and phasing of facilities construction
- Alternative waste treatment and sludge management techniques
- Improved operation and management efficiency
- Energy reduction
- Multiple use of treatment facilities for activities such as education and recreation

A wide range of alternatives is also considered in WQM planning A major thrust of the WQM program is the

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development of Best Management Practices for preventing or abating pollution from nonpoint sources. Methods such as street sweeping and sediment detention basins are being studied at dozens of test sites around the country. These results should be available by the end of 1983, or sooner.

In focusing upon the benefits, drawbacks, and risks of each alternative, it is easy to lose sight of broad relationships and cumulative, long-term effects. Similarly, the tradeoffs between short-term gains and long-term losses should be explored. For example, disruptions during a construction project should be compared with the probable impacts of induced growth and community development. The extent to which a proposed plan would foreclose future options should be discussed.

Pennsylvania The potential loss of wilderness near Philadelphia due to a proposed interceptor project was worth $9 million The foregone benefits made a competing spray irrigation alternative much more cost effective

The evaluation of alternatives shows that different kinds of impacts occur at various points in time

Discussion of Environmental Consequences

The environmental assessment of a WQM or facility plan involves many facets Although the required content of the assessment is given in EPA regulations, the relative emphasis placed upon different elements varies from place to place, and changes from time to time. These impacts occur in different ways

Primary Impacts

Effects directly related to the location, construction, and operation of projects or programs are considered *primary* impacts. They can be either beneficial (positive) or adverse (negative). At the local level, primary beneficial impacts include the removal of disease-causing organisms from wastewater, and the reclamation of poor soils by application of sludge. Negative impacts may include the noise and soil erosion which occur during sewer excavation. Impacts of WQM efforts may be less obvious, but are still important. Destruction of open space, loss of wildlife habitats, and the transfer of wastes out of an area can be problems of regional significance. Beneficial primary impacts of WQM plans include reduced costs through shared facilities, and expanded multiple use opportunities.

Direct impacts are interrelated. If environmental disruption is to be held to a minimum, or costs are to be kept low, a water quality project often should be built within or adjacent to a developed area. However, the aesthetics will suffer because of the siting: unsightly construction, noise, and traffic disruption as a treatment plant is built; other problems such as odors may exist after construction is completed.

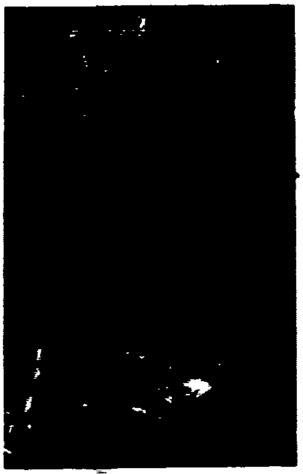
California Planners in Monterey faced an impacts tradeoff The only available sites for a wastewater treatment plant were on prime farmland — a principal source of artichokes for the nation. In the end, agriculture was forced to move to less desirable land

The primary impact is important, but another kind of impact may be even more significant, especially for WQM plans

Secondary Impacts

Indirect effects that are induced by a program or project are called *secondary* impacts. They involve the subtle, often long-term, changes in location, density, timing, and type of development brought about by the construction of treatment facilities Impacts on population, economic growth, land use, and the environment are the main areas of concern. For example, in many areas the siting of sewers and treatment plants directly influences the location of growth within a region.

Secondary environmental impacts from growth and sprawl are numerous New suburbs, shopping centers, industrial parks, and recreation centers may consume excessive energy, and generate air pollution from traffic. Newly built-up areas also contribute to stormwater runoff and nonpoint source pollution. Facilities may induce unwanted urban development that infringes on open space, recreational areas,



Eroding stream bank.

historical sites, or agricultural lands. The scenic character or ethnic makeup of an area can be disrupted by the forces of growth. For example, sewering usually permits dense development such as high-rises and townhouses. The type and quantity of housing in an area, as well as the people who can afford it, may change as an indirect result of treatment facilities

Some secondary impacts are singled out for special attention by federal law They include construction in wetlands, destruction of habitats for endangered species, development in flood-prone areas, and degraded air quality in certain geographical areas Other impacts such as steep slopes may be of special concern to states or communities

In evaluating the alternatives, and describing their environmental consequences, several questions are appropriate:

- **Is a full range of realistic alternatives — both structural and nonstructural types — evaluated?**
- **Are the alternatives consistent with the values of the community?**
- **Does the evaluation consider short-run and long-term tradeoffs, and irreversible commitments of resources?**
- **Are all potentially significant impacts — both primary and secondary — included in the analysis?**

Mitigation of Impacts

An appropriate followup to assessing impacts is studying ways to mitigate (remedy) the adverse effects of alternative plans. In fact, the consideration of mitigating measures is required under the EPA regulations.

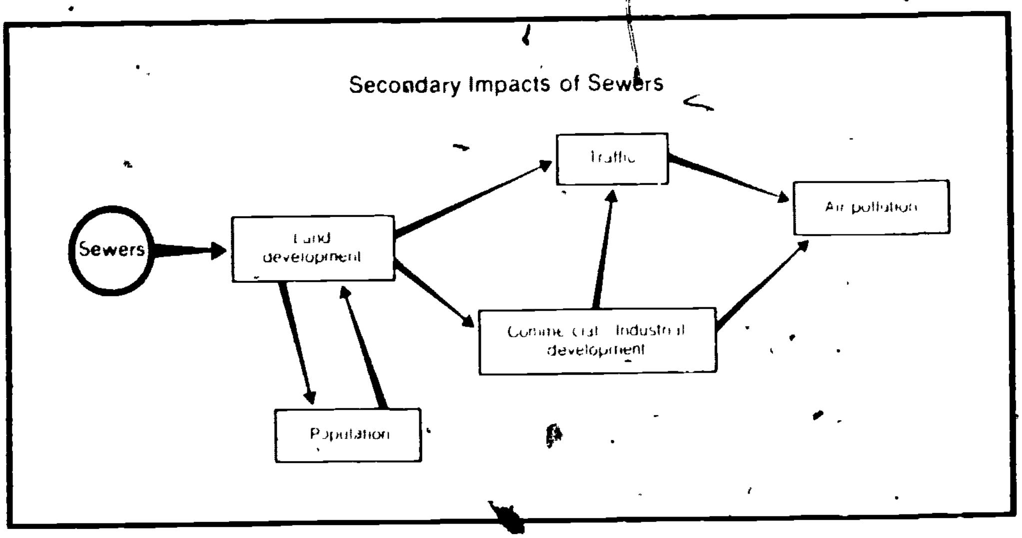
Most primary or secondary impacts are mitigated by several measures Yet, both the measures and the local situations vary It is important to select the measure that best meets the needs of a particular area of the community

Several questions should be considered in selecting mitigation methods:

- **What mitigation techniques are available?**
- **How feasible are these measures?**
- **Who will be responsible for their implementation and enforcement?**

Technique Availability

Primary impacts such as erosion, sedimentation, and noise are generally short-term impacts. They are relatively easy to mitigate through site planning, control of construction activities, and facility operations or program management



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These problems can be kept to a minimum, in part, through thoughtful site selection and working with, rather than against, environmental constraints such as limited terrain An example of mitigative site planning is the use of vegetation as a visual screen, or as a buffer against nonpoint source pollution Another strategy is the control of construction impacts through measures such as restoring disturbed soils immediately, and continually cleaning up debris An additional approach involves proper operating procedures, such as adequate treatment and disposal of sludge to minimize odors

Wisconsin The Dane County Regional Planning Commission, through its WQM program and the local Soil and Water Conservation District, developed an effective agricultural nonpoint source control program Using cost sharing, techniques such as minimum tillage and stream bank fencing were emphasized

Secondary impacts can have long-term consequences that often are difficult to predict and correct Efforts to control them are relatively recent The EPA has identified a range of possibilities for dealing with secondary impacts The list includes project changes such as a reduction in treatment plant capacity, land use regulations such as zoning and subdivision ordinances to protect water quality, restrictions on the number and type of sewer hook-ups A more controversial approach for mitigating adverse impacts involves multiple use activities, such as wastewater treatment facilities used for recreational purposes

Adoption Feasibility

Identifying possible techniques is only the initial step Just as important is the feasibility of implementing a particular mitigation measure Especially difficult are adverse secondary impacts that are not easily mitigated through technological fixes Land use controls such as zoning and floodplain ordinances are usually needed

Communities concerned with stimulating economic development may be unresponsive to land use controls. Even the local land use plans may be inadequate for particular mitigation measures. Therefore, plans and enforcement should be reviewed carefully to determine their effectiveness and feasibility for various mitigation measures. Two other important factors are monetary cost and timing

A major consideration is the cost to the *community* of implementing a technique Some measures, such as the reduction of a service area, may actually bring down project costs Others, such as using existing trees for screening, may have no effect on cost For the community, grant-eligible expenditures are as important as the total costs. Some mitigating actions, such as extending an outfall an extra 100 yards, may make the item grant eligible. Measures that are considered innovative or alternative technologies can reduce the local share of design and construction costs by forty percent[1] However, some mitigating costs, such as acquiring wetlands to discourage future development, may not be eligible for federal grants

Timing is also a key element in implementation Mitigation measures should be considered early in the planning process, soon after impacts are identified Once the engineering designs are completed, or construction is underway, it may be extremely difficult to make changes

Implementation and Enforcement Responsibility

An equally important matter is who will have the responsibility for implementing mitigation measures The planning agency must have the capacity to coordinate the efforts of the many organizations and individuals that are involved. For example, the facility contractor may build erosion and sediment control structures such as detention basins However, an official usually conducts an inspection. The planning agency itself may be responsible for ongoing maintenance The local government generally has the responsibility of implementing land use controls

California. A facilities plan for North Monterey called for the mitigation of construction, operation, and growth-related impacts Over 16 agencies and organizations were identified for possible implementation roles.

In facilities planning, the grant recipient must demonstrate that it has the necessary legal, institutional, financial, and managerial resources to carry out construction, operation, and management — and mitigation of primary and secondary impacts However, areawide and regional arrangements may be troublesome One community or organization may be planning on the behalf of several others. Since several jurisdictions are involved, no single local organization may have the authority to implement mitigation measures outside its own area. Or, it may be a special agency with powers too limited to carry out mitigation projects. Therefore, this situation may require an interjurisdictional authority with powers for implementing mitigation measures Although the local agency executes the mitigating actions, the EPA has the ultimate responsibility to make sure that appropriate measures are adopted This is done by monitoring the planning process

Environmental Assessment in the Planning Process

All planning, even water quality planning, has similar events They include

- Identifying problems
- Establishing goals and objectives
- Compiling data
- Developing and evaluating alternatives
- Selecting a plan
- Implementing and revising the plan

WQM and facilities planning differ primarily in subject scope, level of detail, and regulatory requirements

Advisory Group Activities

Environmental inputs are dealt with throughout the planning process. In facility planning, perhaps even before the advisory group is formed, it is important to discuss potential impacts at the preapplication conference Activity at this point shows local interest, and starts planners thinking about impacts and mitigation measures

Early in the planning process, goals are established and data is collected. Advisory groups can address these concerns by putting environmental issues on meeting agendas Advisory groups can consult with their constituents, and communicate the values and opinions of the public to the planners. Frequent news releases about environmental aspects can interest the community in water projects, and establish on-going support. Fact sheets about programs or projects can be released to the public at the beginning of the process These sheets can be used to point out environmental issues

Advisory groups can be actively involved in developing and evaluating alternatives Subcommittees can be formed to study various aspects, especially from the perspective of the local interests. Resource specialists such as soil conservationists can be invited to contribute their expertise to advisory group discussions In facilities planning, the grantee is required to help identify these parties. This is also a time for assessing mitigation measures Advisory group members and the public can take tours of existing facilities to observe mitigation techniques in operation

Informational meetings are especially appropriate for the plan selection, and the needs assessment early in the process They present an opportunity to make environmental tradeoffs known to the public, and to hold planners accountable for their analyses

Advisory group members should encourage planners to present data and findings in ways that are relevant to the audience Charts and pie graphs may appeal to the general public, while tables of data are more appropriate for technicians Accounts sheets may be an effective way for displaying environmental, economic, and social impacts Similarly, reports can be written with different levels of detail or

summarized for communication with all interests in the community. Tradeoffs should be explained in common terms, such as the effect of the project on the local tax rate, or the project compared with other expenditures such as a new school It must be made easy for people to compare proposals and tradeoffs.

The review of final plans and specifications offer additional opportunities for the consideration of environmental issues In facilities planning, impact mitigation can be made a condition for design and construction grants.

Texas The North Central Texas Council of Governments in the Dallas-Fort Worth area is incorporating water quality into comprehensive planning and development for the region It consolidates input from several technical committees into a Preferred Regional Development Program This program integrates five areas transportation, sewage, water supply, housing, and land use

Place in the Planning Process

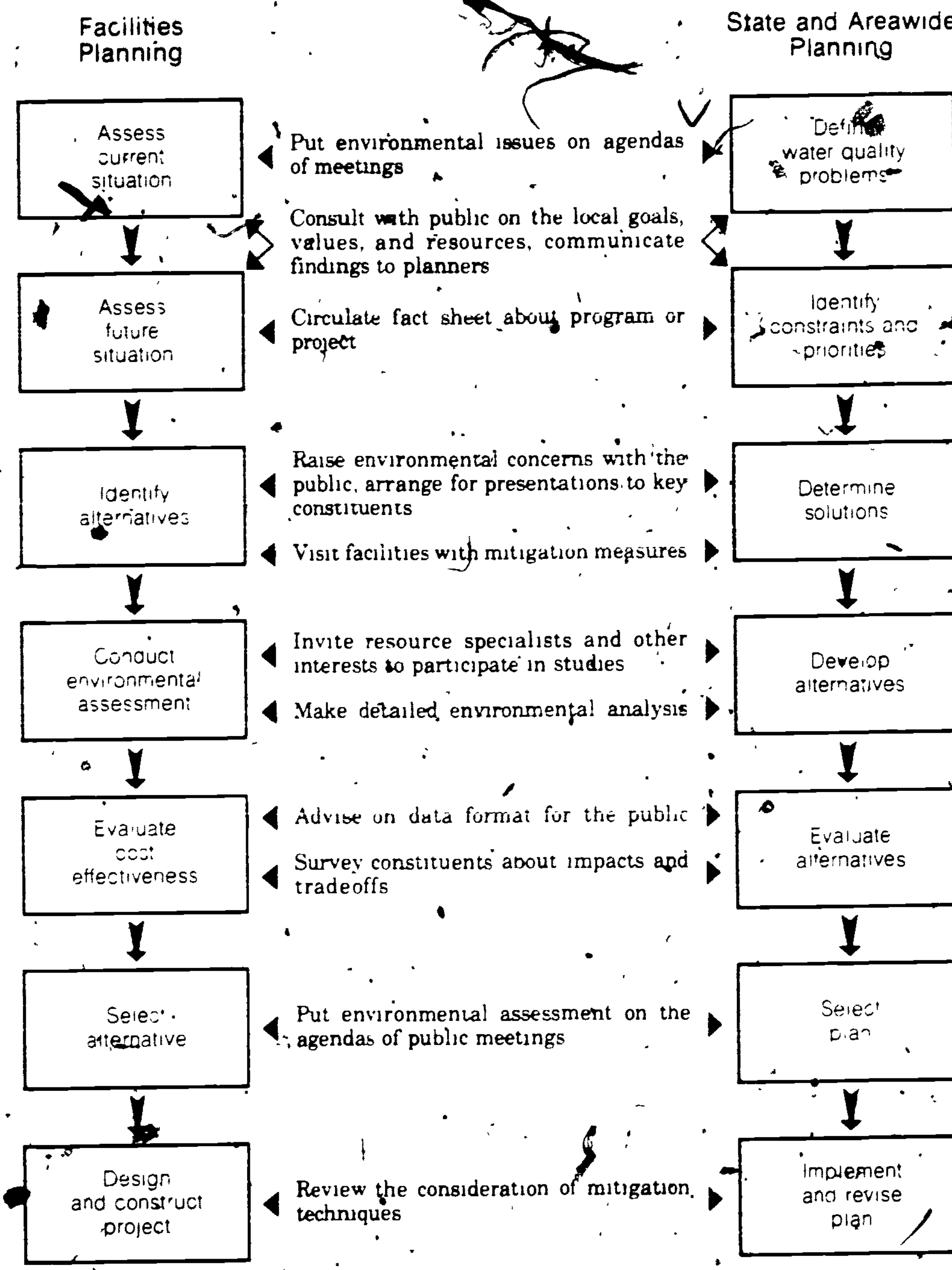
Some persons think that the environmental assessment should be limited to the latter part of the planning process, and handled as a task apart from other planning functions. This can result in plans that overlook environmental issues, and cause subsequent implementation problems. The EPA inadvertently encourages this practice, requiring the submission of the environmental information document separate from the facilities plan.

Proper water quality planning is a back-and-forth process. The assessment of current and future situations goes into the development of alternative plans. The evaluation of these alternatives, in turn, often leads to further studies of the future, and so on Similarly, the environmental assessment proceeds concurrently with all steps in the planning process

Environmental Factors in Planning

Natural features	Cultural factors	Sensitive areas
Surface and groundwater quality	Population	Endangered species
Hydrology and water supply	Housing	Flood plains
Air quality	Employment	Wetlands
Soils and topography	Transportation	Coastal zones
Plant and animal communities	Land use	Wild and scenic rivers
Noise and odors	Historical sites	Agricultural areas
Solid wastes	Recreation and open space	Earthquake zones
Energy resources	Aesthetics	Steep slopes

Advisory Group Activities



Main Points

Because environment means surroundings, the word has different connotations for various persons. To the EPA it means just about everything. Environmental assessments in water quality planning, therefore, evaluate jobs, housing, and aesthetics, as well as water quality, animals, and other natural resources. In water quality planning, environmental factors are as important as monetary costs

Environmental information documents are prepared for all facilities plans. Impact statements are done only if projects are controversial, are expected to have significant impacts, or other circumstances warrant additional studies. Water Quality Management planning is also subject to the environmental assessment process, but WQM plans seldom need an impact statement

Programs have different regulations, and different terms describe the assessment steps. However, the environmental assessment involves the same basic elements: description of current and future environments; evaluation of alternative plans; discussion of environmental consequences, description of measures to mitigate or minimize adverse effects.

Impacts can be either beneficial (positive) or harmful (negative) They also are classified as either primary or secondary, terms which do not reflect their importance, but show their relationships to actions. Primary impacts are due directly to a project or program. Secondary effects, such as growth, are induced or caused indirectly by a project.

Successful projects require the mitigation of adverse impacts. The choice of mitigation measures depends upon technique availability, implementation feasibility, and enforcement responsibility Secondary impacts are generally more difficult to mitigate

WQM and facilities planning programs have different specific requirements, but they have the same basic planning elements. Both involve: identifying problems; establishing goals and objectives, compiling data; developing and evaluating alternatives, selecting a plan, implementing and revising the plan.

Advisory groups can ensure that environmental aspects are considered throughout the planning process Meetings, public hearings, fact sheets, project reviews, and other occasions are opportunities for citizen involvement Maximum information exchange between the planners and the public requires different kinds of communication approaches for the diverse public and discussions in common terms.

Environmental assessment plays a key role in soil conservation planning.

Case Study

Mitigating Growth Impacts and Protecting Wetlands

Block Island, Rhode Island

Adapted from Municipal Wastewater Management Citizen's Guide to Facility Planning *by Clem L Rastatter editor Washington DC U S Environmental Protection Agency Office of Water Program Operations, January 1979*

Block Island is a small island located roughly ten miles off the coast of Rhode Island It supports a small year-round population of about 500 residents During the summer, the resident population increases to 1,700, and on a typical summer day another 1,000 - 2,000 tourists may be visiting the island

Development on the island has been concentrated in the Old Harbor area Hotels, inns, rooming houses, restaurants, and shops are clustered along the old harborfront To the northwest, more recent development has taken place in the New Harbor area The remainder of the island is largely open heath, pasture, numerous ponds and inland wetlands Of the island's nearly 7,000 acres over 5,000 are in heath and open pasture, and another 1,000 acres are in water and wetland

In 1972, the island adopted a comprehensive development plan The goals and policies outlined in the plan include protecting environmentally sensitive lands and natural areas, preserving the rural New England character of the island, and confining development to lands with soils suitable for septic tanks In 1973, the township updated its 1967 zoning ordinance to conform with the new plan, and to ensure the protection of wetlands, ponds, and streams

The Problem

Until the late 1960's, the primary wastewater disposal method on the island was onsite sewage systems, usually with the direct discharge of raw wastewater into the ocean In the early 1970's, a ban on raw ocean discharge caused a switch to subsurface disposal

The high density in the Old and New Harbor areas, however, did not allow enough land for adequate subsurface disposal, particularly during the peak summer season New construction, which was increasing at the time, placed additional strain on the capacity of the soils As a result, many onsite systems failed, creating a situation that was aesthetically displeasing to the residents It also represented a potential community health hazard

Proposed Solution

Because of the serious sewage disposal problems, island officials hired a consulting engineering firm to study the situation and develop tentative plans for a municipal collection and treatment system Next, the township began application proceedings for federal aid It then contracted with the same engineering firm to design, supervise construction, and start operation of the recommended waste disposal system

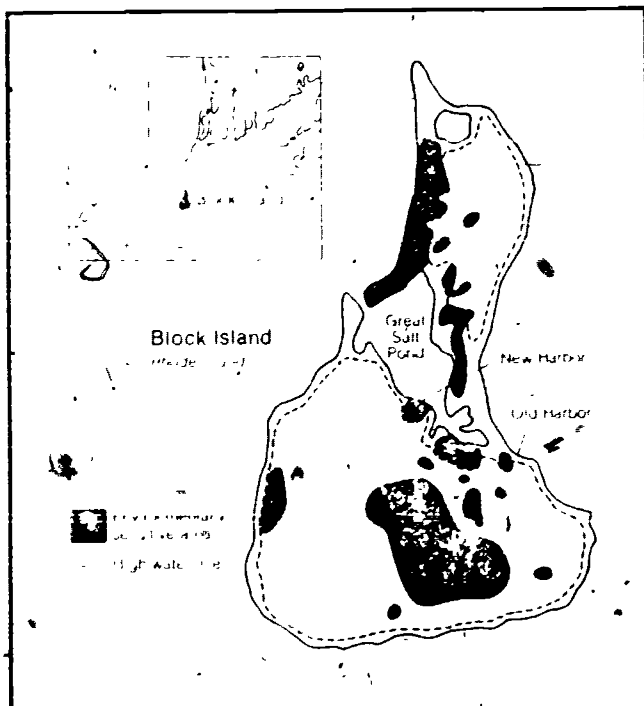
The initial plan called for the construction of a secondary wastewater treatment plant, sewers, and an outfall off the breakwater near Old Harbor The system (0 28 mgd) was designed to initially serve both the Old and New Harbor areas, with provisions to serve the area south of Old Harbor in the future

Based on the environmental assessment, the EPA issued a Finding of No Significant Impact However, in six months the project had become the subject of serious public controversy Citizens discovered that the project would cost $2 6 million more than was originally estimated It would also have serious growth implications for their community The EPA Regional Office, recognizing the serious nature of the community concerns, reversed its decision and decided to prepare an environmental impact statement

Issues Raised

Both the draft and final environmental impact statement discussed in some detail the project's possible secondary land use impacts Based on the experience of other island resort communities, and depending on the demand for zoning changes and expanded treatment capacity, the statement warned that the following secondary impacts could result

- Develop resorts and residences on wetlands, shorelines, and flood-prone areas
- Facilitate condominium and high-density residential development on the extensive open moors
- Intrude upon the character of open space, especially the view of Great Salt Pond and Block Island Sound



- Degrade water quality through runoff from additional paved and impermeable surfaces, through erosion and sedimentation associated with construction activities, and through solid waste-septage disposal and septic systems
- Increase noise levels through additional vehicles, lawnmowers, and human activities
- Degrade air quality through additional motor vehicles and power boats
- Disturb the fragile ecosystems of marshes, dunes, and upland plant and animal associations

The Alternatives

The proposed project alternatives were carefully analyzed to ensure that an extreme growth situation would not occur, and that the severe secondary impacts would be avoided. The analysis concentrated on what were considered the four most practical choices.

Alternative A. Construction of a treatment facility and collection system to serve the Old and New Harbor sections of the island, with provisions to serve the area south of Old Harbor in the future

Alternative B. Construction of the project without provisions for sewering the area south of Old Harbor in the future

Alternative C. No sewer construction, but a comprehensive program for rehabilitating individual septic systems

Alternative D. Construction of a treatment facility and collection system for the Old Harbor area only, with rehabilitation of individual septic systems in the New Harbor area

The draft impact statement recommended against allowing the situation to remain unchanged (a "do nothing" alternative), and against trying to solve the problem simply by upgrading existing individual septic systems (Alternative C) Also rejected was the original proposal (Alternative A), which was about to be enacted when the citizens raised their protests This alternative was eliminated because wetlands and other environmentally-sensitive areas made up a large portion of the area proposed for future sewers The draft impact statement recommended alternatives B and D

Of these two recommended alternatives, the draft statement favored Alternative D Pressures for induced growth would be minimized, particularly along the strip between the two harbors However, due to the insistence by the Rhode Island Department of Health that septic systems could not be made adequate in the New Harbor area, the final environmental impact statement recommended Alternative B It also advocated that both commercial areas be served by public sewers, rather than the Old Harbor area alone

Mitigation Measures

Scaling down the original project design was the first mitigating measure Eliminating Alternative A reduced the size of the service area This meant that the project would not induce growth on wetlands and other environmentally-sensitive lands south of Old Harbor

The second mitigating measure involved a specific directive to protect wetlands on the periphery of the two harbors, and lands adjacent to interceptors carrying wastes from the New Harbor to the treatment plant in the Old Harbor

The EPA attached a condition to the facilities grant It required the grant recipient to protect wetlands by partially controlling the new growth through hook-up limitations

It is important to note that this condition reaffirms Rhode Island law on the protection of wetlands, and that it supports policies contained in the local comprehensive plan and zoning ordinance

Need More Information?

Environmental Assessment of Construction Grant Projects FRD-5 EPA-430/9-79-007 Washington, DC U S Environmental Protection Agency, January 1979 58 pp.

This manual is designed to aid grantees in the preparation of environmental assessments for wastewater treatment facilities. Using a checklist format, it discusses the types of environmental factors which should be considered in environmental assessment It has four chapters which deal with procedures for identifying and assessing impacts, types of pertinent man-made and natural features, hazardous or sensitive areas, and conservation of natural resources Federal laws and regulations are mentioned and the minimum and supplemental requirements of the assessments are given Copies are available from General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225 Give the FRD number and the publication title when ordering

Environmental Assessment of Water Quality Management Plans Washington, DC U S Environmental Protection Agency, January 1977 108 pp

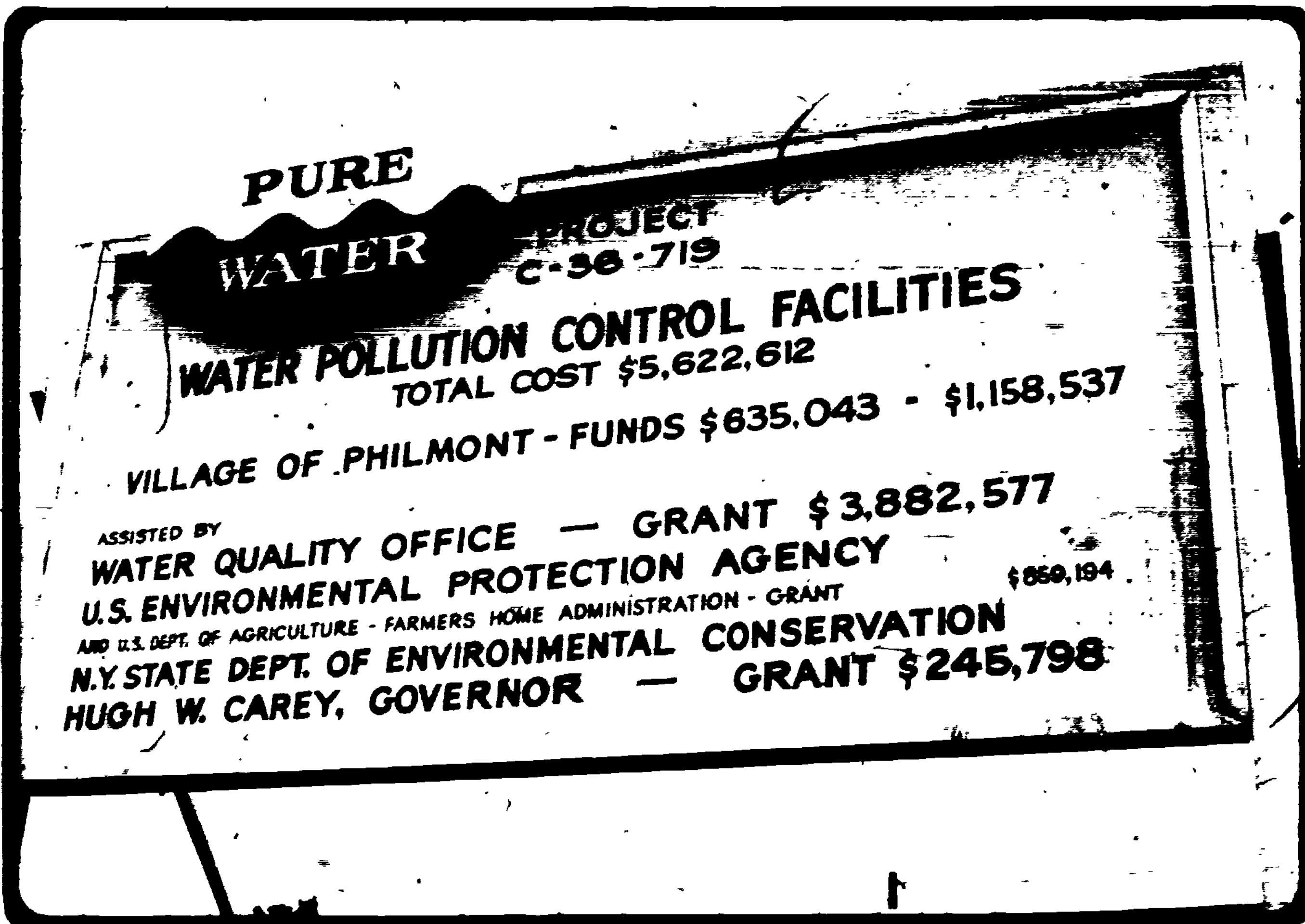
This report is designed to assist managers and staff of planning agencies in assessing environmental impacts of water quality management plans In addition to an overview, chapters are devoted to land use, air quality, water quality, visual quality, and ecological economic, and social impacts These chapters discuss parameters appropriate to the topic, baseline development, and assessment methods Key questions about each topic also are featured Copies may be obtained from the U S Environmental Protection Agency Library Services, Mail Drop No 35, Research Triangle Park, NC 27771 When ordering, give PDS No 3471

Leffel R Ernest, *Direct Environmental Factors at Municipal Wastewater Treatment Works* EPA-430 9-76-003 MCD-20 Washington DC U S Environmental Protection Agency January 1976, 104 pp

This report is primarily limited to a few categories of impacts at municipal wastewater treatment facilities, but it does contain a good summary of evaluation and control measures of environmentally-sound projects It has a comprehensive section on facility planning and site design Other chapters discuss airborne pollutants, noise, and site problems To order this publication write General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225 Indicate the MCD number and the title of publication when ordering

Rastatter Clem L., ed *Municipal Wastewater Management Citizen's Guide to Facility Planning* FRD-6 Washington, DC U S Environmental Protection Agency, Office of Water Program Operations, January 1979 263 pp

This handbook is designed to acquaint citizen leaders with important decisions that need to be made in managing wastewater The book identifies key decisions throughout the planning process that are critical to the facility plan and the community, identifies environmental, economic, and social considerations affecting these decisions, facilitates citizen input and helps citizens understand the legal tools to facilitate their involvement Regarding environmental assessment the book focuses upon primary and secondary impacts and mitigation measures It is available from the General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO 80225 Indicate the FRD number and title of publication when ordering


PURE
WATER
PROJECT
C-36-719
WATER POLLUTION CONTROL FACILITIES
TOTAL COST $5,622,612
VILLAGE OF PHILMONT - FUNDS $635,043 - $1,158,537
ASSISTED BY
WATER QUALITY OFFICE — GRANT $3,882,577
U.S. ENVIRONMENTAL PROTECTION AGENCY
AND U.S. DEPT. OF AGRICULTURE - FARMERS HOME ADMINISTRATION - GRANT $859,194
N.Y. STATE DEPT. OF ENVIRONMENTAL CONSERVATION
HUGH W. CAREY, GOVERNOR — GRANT $245,798

Chapter 12

Financial Management

Dennis W Auker and Irving Hand

Achieving clean water can be expensive[1]

- More than $25 billion in federal funds have been spent on the planning and construction of wastewater treatment facilities in the decade following the passage of the Clean Water Act of 1972 [1]
- From 1974 to 1980 the federal government invested nearly a quarter billion dollars in state and areawide water quality planning
- Due to poor planning, a lack of planning, or unexpected events, the residents in some communities pay over $800 in annual sewage charges

The implementation of water quality programs in the face of rising costs raises many questions for states and local communities They need to know how much they can afford to pay, who will pay, and how they can pay The answers to such questions are crucial to the success of any project or program

Water Quality Planning

Water quality planning is done on several levels State and areawide planning, called water quality management (WQM) planning, aims at providing a framework for the coordination of local plans. It also focuses upon broad problems such as nonpoint source pollution Another type of water quality planning, wastewater facility planning is usually directed at the local level There are also other types of planning such as river basin planning Financial management has a role in each of these types of planning and helps implementing agencies meet their financial responsibilities

The analysis and administration of the financial aspects of water quality planning, construction, and operations is called *financial management* The benefits of financial management are numerous Besides indicating total project costs, financial analysis leads to an estimate of the local share of the costs, and identifies secondary or indirect impacts such as the energy needs of various project alternatives which can affect the costs borne by communities. ~~Unfortunately~~, financial management has been hampered by several factors, including

- The absence of information on how to manage the financial aspects of water quality projects
- Limited application and testing of financial analysis methods
- The reluctance of technicians and financial experts to investigate each other's points of view
- The hesitancy of some persons to face tough financial issues out of concern for political consequences
- The lack of trained personnel at the local level

While most water quality plans are technically acceptable, many fail to consider adequately the important financial and institutional issues affecting funding and implementation This lack of information and analysis makes it difficult for local planners and decision makers to evaluate alternative costs and institutional arrangements. This, in turn, makes it difficult to obtain the commitments which are necessary to implement plans

Many personnel at the state, regional, and local levels view financial and institutional analysis as outside the usual realm of technically-oriented planning. However, federal, state, and local governments are now facing increasingly stringent financial constraints which are forcing a careful analysis of the local community's ability to finance water quality programs and projects.

The advisory group should recognize the need for financial management and support its implementation. Without adequate financial management, a community may end up with a water quality program that it cannot afford or completely accept.

Benefits of Financial Management in Planning

- Determination of total costs for project alternatives
- Estimate of the local share of various costs
- Assessment of the capacity of the community to finance its costs
- Identification of alternative funding sources and revenue-generating systems
- Allocation of costs among communities and institutions
- Equitable distribution of costs among users
- Assessment of the financial impacts of institutional arrangements and responsibilities
- Identification of secondary impacts such as energy use

Financial Management Principles

Financial management must occur as early as possible in the planning process Prompt consideration helps to assure the adoption of affordable solutions to water quality problems Continuing financial management throughout the planning process is then necessary to ensure that the final cost estimates and financing strategies are sound and acceptable Specifically, early analyses are based upon assumptions about service levels, engineering requirements, financial capabilities, and institutional arrangements These assumptions may change later in the planning process, requiring reevaluation of previous conclusions

Accurate financial management analyses require a clear understanding of the water quality planning process and the decisions to be made at each step in the process Four important steps in water quality planning include

- Assessment of the current situation
- Assessment of the future situation
- Environmental assessment
- Cost-effectiveness analysis

An accurate analysis of the current situation requires data on population, wastewater facilities, pollution, regulations, and institutional characteristics This information is needed, for example, in order to determine whether to repair existing systems or to build new ones

The assessment of the future situation leads to a more detailed financial analysis A whole series of issues related to financing is addressed, including the estimated rate of population growth and distribution, and projected land uses, including the kind and density of activities Other important issues are wastewater quantity trends, including infiltration and inflow factors, and projected industrial wastewater contributions to municipal wastewater treatment facilities Each of these issues has a major effect upon the financial picture of water quality planning

An environmental assessment evaluates the effects of various wastewater treatment or pollution control alternatives on surface waters, sensitive areas such as wetlands, population change, economic growth, land use, and other factors The impact of each on the financial aspects of the plan must be studied.

In facility planning, the final selection of a wastewater treatment alternative is completed within the framework of cost-effectiveness analysis. The most cost-effective solution is the one with the lowest overall monetary costs which meets water quality goals without overriding environmental drawbacks However, the cost-effectiveness analysis does not include a consideration of a community's ability to pay Therefore, the financial management analysis should evaluate the impacts of the cost-effective alternative itself upon a community's financial resources

Water Quality Planning

- Assessment of the current situation
- Assessment of the future situation
- Identification of alternatives
- Environmental assessment
- Cost-effectiveness analysis
- Selection of the recommended alternative
- Selection of management and financial arrangements

Certain principles of financial analysis apply throughout the planning process

- The presentation of cost information should be based on the cost to an individual user or a single household
- The impacts of the water quality program on the financing of other public programs should be identified
- The funding scheme must be perceived as equitable. To the extent possible, those who benefit should pay for services

The advisory group can help to assure that the financial aspects of the project are not ignored until the last moment when little can be done. It is important that the advisory group know the key steps in the planning process, and the types of financial input that are crucial at each decision point.

Wisconsin. On the Fox River between De Pere and Lake Winnebago is a concentration of ten paper mills and four municipalities They collectively achieved a 90 percent reduction in organic wastes discharges, but still could not meet the water quality standards An areawide planning group, the Fox Valley Water Quality Planning Agency, with a WQM grant, used financial considerations in developing innovative wasteload allocation strategies such as flow and temperature-related permits, stream segment wasteload permits, and in-stream aeration Although all of the approaches have not been approved by the Wisconsin Natural Resources Board or the U.S EPA, they allow water quality goals to be met without creating financial hardships for the dischargers

Costs of Clean Water

The costs of clean water can be substantial For wastewater treatment facilities, the major costs are associated with design, construction, operation, and management. Funds from the U S Environmental Protection Agency (EPA) normally cover 75 percent of the eligible planning, design, and construction costs. However, local communities must bear the burden of the remaining costs, including long-term operation and management expenditures For state and areawide WQM programs,

federal funds have covered much of the initial planning costs Again, states and local communities have the financial responsibility for implementation and operation costs

The determination of the costs for a particular water quality project or program can be a long and complex process It is one, however, that is essential. Local decision-makers need a thorough understanding of costs in order to make comparisons among the water quality alternatives and activities that compete for community resources. Specifically, the local share of costs must be identified to assess how other local programs such as streets or schools may be affected through budget limitations.

Much cost information is developed through water quality planning efforts However, most cost studies focus upon engineering factors. Cost-effectiveness analysis permits the systematic comparison of wastewater management alternatives, but is primarily designed to help the engineers and planners select alternatives

Cost information should also be developed to meet the specific needs of persons who will be affected by a project and those who will have implementation responsibility Cost estimates for industry, business, and homeowners are crucial in determining how alternative pollution control systems will affect a community Likewise, cost information is needed to assure that agencies charged with implementation, such as a sewer district, have the ability to effectively perform the necessary tasks

Most cost determinations are made by professional engineers working in consultation with agencies responsible for the planning activities An understanding of the technical aspects of water quality projects and programs is necessary to accurately estimate costs However, costs are affected by factors such as service areas, future land uses, and population projections, which should not be determined solely by the engineers These determinations should be developed in coordination with the local governments that are directly charged with land use planning and regulation responsibilities

Facility planning and management suggest that costs be developed for capital and operating expenditure for five-year intervals over a 20-year period Wastewater system costs include collection lines, interceptor sewers, pump stations, force mains, sewage treatment, and sludge disposal. Where phased construction is expected, the land use implications of population growth and distribution should be determined. This cost data should deal with each phase for the entire system, and be available for review and comment by the participants in the planning process, including the advisory group The planners should analyze how much each alternative will cost each individual user on a monthly basis

Federal Grant Eligibility

In determining the local share of costs, the expenditures that are eligible for federal funds must be distinguished from those that are not In facility planning, eligible costs under the EPA Construction Grants

Program include planning, design, construction costs (such as the facility itself, lab equipment, land purchases, and interceptor sewers), start-up assistance, and development of a user charge system or pretreatment program Ineligible for EPA funding are costs for sewer hook-ups and for the long-term operation, management, and replacement of the treatment facility Local wastewater collection lines may also be ineligible

In the past many grantees failed to properly identify the costs that were eligible or ineligible for federal funding support The true local costs for an alternative facility or program were either unknown or were incorrectly estimated and documented This deficiency was especially prevalent for operation and maintenance costs Thus, the end result was higher wastewater treatment costs that had to be paid by the local community

California Five million dollars in expenditures on a $6 million wastewater treatment facility in Coachella Valley were declared ineligible for federal funds. Because of possible overdesign, the 6,000 residents of the area may have to pay for almost all of the facility. The state is now assisting the community in its administrative procedures to avoid such a devastating loss to the community

The advisory group should make certain that the community knows which costs are ineligible for EPA funding. It is the community's responsibility to bear these costs.

Costs of Future Growth

The future growth of a community may play a major role in determining the costs of clean water The type, amount, and location of growth may affect not only the size of the treatment plant, but also the need for constructing and maintaining sewers The type of growth that occurs is one important consideration. Industrial, commercial, and residential land uses will generate different pollution control needs with corresponding costs Even within a particular land use category, there may be varying treatment needs For example, multi-family residences often have per capita wastewater flows which differ from single family homes located on large lots Similarly, agricultural lands can yield different nonpoint source pollutants such as pesticides and sediment

It is important to estimate, as accurately as possible, the types of future land uses and the time likely for their development Failure to do so can result in financial hardships for the community For example, inaccurate growth projections have sometimes led to the construction of oversized wastewater treatment facilities that have large capital, operation, and management costs In these instances, existing users must support both their portion of the total costs and that which the new population was expected to provide

Growth Issues

- How and where should the community grow?
- Can the growth be managed either directly through land use controls, or indirectly through the location of sewers?
- Can the community afford to pay the costs for new sewers to serve the growth areas?
- What options exist for funding future growth?
- Will adequate funding be available for programs or projects to accommodate future growth?

Funding Sources

In this time of rising costs and tax burdens, it is no easy task to secure the funds that are necessary for wastewater treatment and the control of nonpoint sources of pollution Funds are available, however, and their sources should be identified and studied through financial management analysis In general, potential funding sources can be grouped into three categories. intergovernmental sources of capital such as loans and grants from the Farmers Home Administration and the EPA, local sources of capital such as general obligation bonds and special assessments; and local sources of operation, management, and replacement income such as connection charges, inspection fees, and user fees

Funding Sources for Water Quality Management

	Source or System	Description
Intergovernmental Sources of Capital	• FmHA* Community Facility Loans and Grants	Loans or grants used to construct or improve sewage systems. Community must demonstrate financial need
	• State Grants	Grants usually used to decrease the local share of federally-funded projects.
	• HUD** Community Development Block Grants	When used for water pollution control purposes, the grants can be used only for sewers, not a treatment facility
	• EPA Construction Grants	Grants normally of 75 percent for planning and constructing a treatment facility, 85 percent for the use of innovative or alternative technologies
Local Sources of Capital	• General Obligation Bonds	Bonds usually paid for through an increase in taxes These bonds may be subject to a voter referendum
	• Revenue Bonds	Bonds paid for by revenues generated by the community facility Higher interest rates than those for general obligation bonds may often apply
	• Special Assessment Bonds	Bonds issued to pay for public improvements where specific and direct private benefits exist Payments from parties who receive the benefits retire the bonds Interest rates are normally higher than general obligation bonds A special assessment district is required for this type of funding
Local Operating Income Sources	• Ad Valorem Taxes	Taxes computed on the assessed value of all property, real and personal, often considered regressive and unfair, normally an unpopular method
	• Income Taxes	Taxes computed generally as a percent of income, either as an increasing percentage, or as a constant percentage of income Some local jurisdictions may not have the legal authority to impose income taxes
	• User Fees	Prices charged to the consumers of various public services The charges may vary among user categories and locations due to differences in the costs of providing services Generally a favored approach, although it may be a burden to low-income households

*Farmers Home Administration
**Department of Housing and Urban Development

If communities are to finance the local costs for water quality programs in an economical and equitable manner, it is important to examine the advantages and disadvantages of the full range of capital and revenue-generating mechanisms. For example, various funding sources can change due to legislative actions or innovations in bond payment and other financing techniques. Federal and state assistance programs may also change. Other issues can affect the ability of a community to secure funds. These include the eligibility of a community to receive funds from the different federal agencies, and limitations or requirements on those funds.

Funding Source Issues

- Is the community or local agency eligible to receive funds?
- Are there limitations or requirements for using the funds?
- Can the local agency meet application requirements?
- Is voter approval necessary for a specific funding method?
- Does the funding source impact on citizens in an equal or fair manner?

Financing the Local Share

Of great importance and interest to a community and to advisory groups are the issues surrounding the financing of the local share of costs. Various revenue-generating mechanisms can affect a community in different ways. For example, the local costs of a project may be financed from general fund revenues. In this case, the general population supports the project through an increase in taxes. More often, however, self-supporting revenues specific to the project, such as special assessments and user fees, must be secured. Support for these types of mechanisms comes from those who benefit from the project.

Michigan. The 234 units of government in the Southeast Michigan Council of Governments (SEMCOG) conduct ongoing water quality planning with a self-financing mechanism. Using a cost-sharing formula based upon both sewage flow and land area, SEMCOG is able to spread the cost for planning across the entire population in the region. The funding arrangement was selected after an examination of about two dozen alternatives based on criteria that included equity, legality, and political feasibility. It was designed to pay the local share required to obtain WQM funds for continuing planning.

The effect on a community's capital improvement program is another consideration to be made in analyzing local finances. When a community undertakes the responsibility for a wastewater treatment facility or nonpoint source control program, the financial resources available to the community may be stretched. Thus, monies that can be used for other purposes, such as roads or schools, may not be readily available. Higher interest rates may also exist for loans that can be secured.

Community Finance Issues

- What is the community's ability to incur further debt?
- How do the future needs for capital relate to the capacity to borrow?
- How will the project affect the community's other capital investment priorities?
- How will the project schedule affect the financial alternatives?
- To what extent will the project induce growth, increase demands upon existing infrastructure such as schools and roads, or increase the need for expansion?
- Will the facility provide an incentive for growth that may increase tax revenues?
- Does the financial analysis for the water quality program or project provide sufficient information for making decisions?

Who Pays and How Much

The determination of who pays and how much is crucial in developing acceptable local funding mechanisms. A first step is the identification of who is to benefit from the project or program A clear recognition of the beneficiaries is necessary before the public can be expected to support a project Business, industry, and homeowners may all benefit directly, for example, from a wastewater treatment project. The community as a whole also may benefit from the project as its lakes and streams become cleaner Various groups may benefit differently, those differences should be reflected in how much each pays

The issue of equity or fairness is also important in determining who pays and how much How fees are established for new as opposed to present users, different income level groups, and for business, industry, and homeowners are some of the decisions that need to be made.

> **Equity Issues**
>
> - Will new users be treated the same as present users?
> - Should there be entry fees for those in new growth areas that wish to extend the sewer system, or service charges for undeveloped tracts?
> - What is the basis for determining connection fees?
> - Are there portions of the community's low-income population who will not be able to afford the utility bills?
> - How will the revenue-generating system affect families who wish to move into the community?
> - Will the system unduly burden property owners?
> - Will the costs adversely influence future economic growth?

The funded agency should consult with the advisory group about the distribution of costs among present and future users. An evaluation should be made both of the relative contributions by various types of users, and the ability of each to pay its share of the costs.

User Charges

User charges are the major way in which communities generate revenue to cover operation, management, and replacement costs In developing a user charge system, the issues relating to who benefits, who pays, and how much should be considered

In wastewater facility planning, the development of a user charge system is required by the Clean Water Act Specifically, a user charge system must

- Distribute costs to each user, or user class, in proportion to the user's contribution to the total waste load of the treatment facility
- Provide for the total operation, management, and replacement costs of the treatment facility
- Undergo reviews and revisions to reflect the actual costs where necessary
- Operate under legislative enactment by the appropriate authority

Nonpoint source control programs can also recover operation, management, and replacement costs through user charges For example, routine septic system inspections and other management functions can be financed through a user charge system There are no specific requirements for user charges in nonpoint source control programs, however

Impact of Institutional Arrangements

Institutional arrangements have an impact on who will bear the costs and who will obtain funding. They involve the assignment of responsibilities to governmental agencies or private organizations. Financial management requires the identification and assignment of responsibilities required for the implementation of a program. Responsibilities can be assigned to various institutions These include

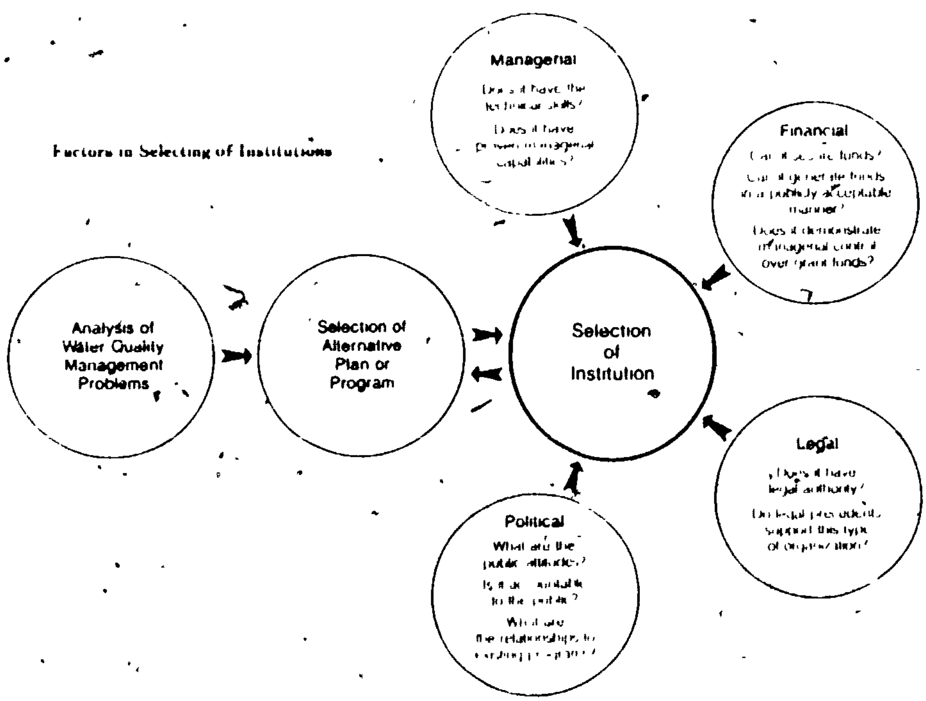
- An informal working group within an existing governmental department
- A new or existing governmental department
- A county, city, or other municipality
- A new or existing special district authority
- A new or existing regional organization
- A new or existing state agency
- A federal agency
- An organization formed by an intergovernmental contract
- A private entity such as a private utility

The major considerations in selecting an institution are managerial, legal, political, financial, and public acceptance factors. Effective management of a wastewater treatment facility or a water quality management program requires administrative activities such as continuous planning, operation, management, monitoring, and regulation. It is important to keep in mind that not all agencies have all the necessary authority and capabilities, responsibilities are often shared.

The advisory group can help identify and resolve issues related to the establishment of appropriate institutional arrangements.

The advisory group should discuss issues such as the political accountability, financial responsibility, administrative capability, and technical ability of the institutions.

Factors in Selecting of Institutions

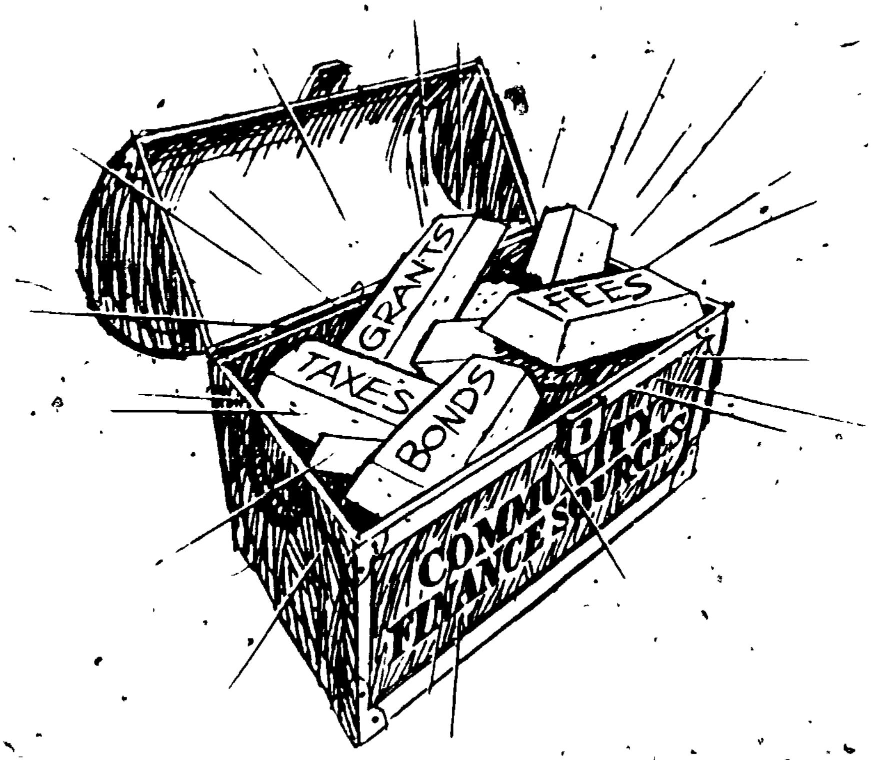


Secondary Impacts in Financial Management

During planning, issues should be raised regarding the broad, indirect consequences of proposed actions. These indirect effects are called secondary impacts. For example, cleaning up a stream may improve fishing and attract tourists who spend money in the local economy, thus increasing community revenues. On the other hand, the extension of an interceptor sewer across undeveloped lands may encourage growth and increase the demand for governmental services, thereby placing stress on a community's budget

Numerous secondary impacts can accompany a water quality project or program Impacts with financial significance include economic development, governmental cooperation, growth projections, community programs, multiple use opportunities, energy demands, and groundwater pollution

The project may affect the potential for economic development, By providing additional treatment capacity, a new industry may locate in the community On the other hand, additional sewer charges may force some industries to close or move



A project may enhance or interfere with local intergovernmental cooperation If a project serves both city and county residents, agreement must be reached on service areas, and the equitable treatment of users in each jurisdiction

A project is vulnerable to speculative growth projections. Building for future growth does not guarantee that growth will occur If it does not take place, the system users will have to pay higher unit costs to retire the local debt and ensure proper operation and management Similarly, a change of existing treatment capacity will lower or raise the unit costs to all system users A substantial increase in unit cost can have an adverse effect on, low and fixed-income families

A project also may have revenue effects on other community programs If the project uses up most or all of the community's debt capacity, other community projects such as a new town hall, parks, water supply improvements, and roads may not be financially feasible

A project can present opportunities for multiple use activities such as recreation If the project can be integrated into the community's open space plans by using sewer rights of way for hiking trails or by converting a land disposal site into a park, costs to develop these recreational opportunities can be reduced

A project may significantly alter the energy demand relative to other wastewater treatment alternatives Projects also can require various amounts of other resources such as chemicals and land

A project may affect groundwater pollution, either degrading or enhancing public or individual water supplies For example, a project may transfer water out of a watershed and diminish the recharge of local aquifers. On the other hand, where groundwater pollution has been a problem, improved onsite wastewater system management can eliminate the need for, and expense of, new sources of water supply.

The advisory group can lend many insights into the significance of the secondary impacts of water quality projects and programs.

Financial-Institutional Plan

Concerns such as costs, funding sources, institutional arrangements, and secondary impacts can be dealt with through a financial-institutional plan All water quality plans should include a financial-institutional plan or element. This element should allow local officials, policy makers, and citizens to understand the approach to the issues of who pays, how much, and when As a minimum, it should provide information about the participating agencies, their responsibilities, estimates of all project costs, the funding sources for each cost, and the expected burden on each local citizen and affected institution The financial-institutional plan is a *decision* document It must do more than simply raise issues It also records decisions made and actions to be taken

In developing the plan, analysts should discuss potential constraints, implementation problems, and risks Some of the issues are

- An altered bond rating which may severely affect a community's ability to borrow money and the costs of these funds
- A voter referendum that may determine the type of funds that can be used to finance a program
- A change in population growth that will affect the program implementation and the costs to users

The advisory group should make sure that the financial-institutional issues important to the community are adequately addressed in water quality plans.

Advisory Groups in Financial Management

The role of the advisory group is to help an agency plan, develop, and manage a water pollution control project or program. The goals are to avoid undue financial burdens for the community, and to see that residents get their money's worth

The advisory group can play an important role in gauging the public perceptions of the need for a project or program and the willingness to pay for it. The advisory group can assist communication among the planners, engineers, and the public about the program costs and benefits.

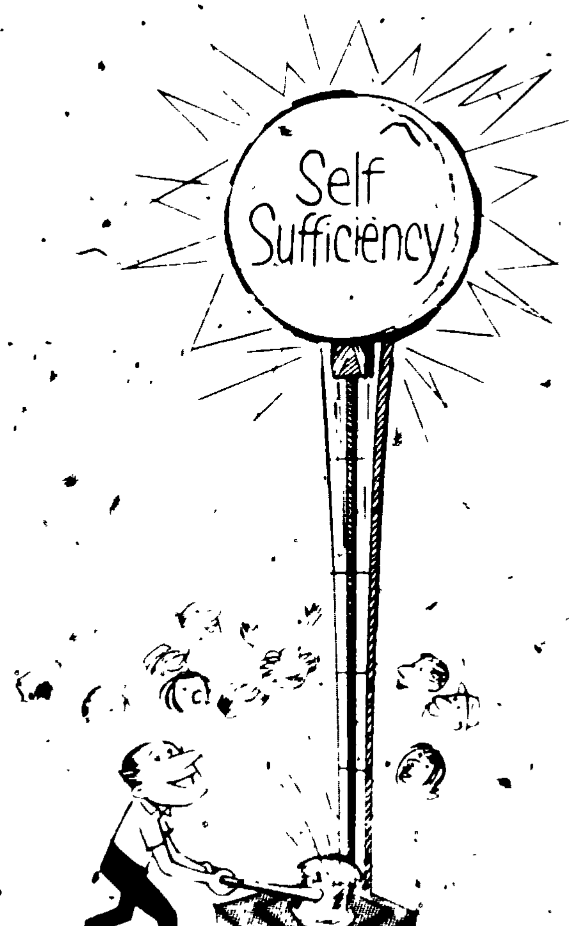
Since the advisory group represents a cross-section of the taxpayers and residents who will pay for water quality projects, it makes sense to involve the group in reviewing how the money will be managed to achieve the desired benefits. The advisory group serves to:

- **Bring forth views about whether the community can afford and will support a project**
- **Help identify financial and institutional issues in the community that should be addressed during the planning process**
- **Offer ideas about how management agencies should function in order to meet community needs and problems**
- **Develop an understanding of the agency's mission and the problem it faces in financing a project**
- **Take time to review the financial analyses and ask appropriate questions about the results**
- **Help determine what is equitable regarding a proportional cost-recovery system.**

Summary

Financial management can help a community determine how much it will cost to achieve water quality goals, and the most equitable methods of payment. The integration of financial management with other water quality planning tasks should be accomplished as early as possible in the planning process. It should then be continued through to operation of the wastewater treatment facility or to implementation of the water quality management program

Cost information is important to local decision makers for comparing alternatives, for determining the impact on other local programs, and for evaluating the impact on users and implementing agencies The local share of the costs should be expressed in terms of cost per user



In planning, several important assumptions must be made which have financial impacts, including service area, future land uses, and population projections They should be developed by city and county governments The advisory group can help to assure that these assumptions are properly addressed

Available funding sources depend on community resources and legislative actions In general, potential revenue sources can be grouped into categories that include intergovernmental and local sources of capital, operation, management, and replacement funds The advisory group can help to identify issues that relate to particular funding sources

Who benefits and who pays are important issues to be considered in developing water quality plans Costs should be equitably distributed among users The user charge system is a method developed by the agency to distribute local operation, management, and replacement (O,M&R) costs The local share of the capital costs for construction may be recovered by user fees or sewer bills, ad valorem taxes. and surcharges

Institutional arrangements involve the assignment of responsibility for water quality management The factors to consider in selecting institutions include managerial, legal, political, financial, and public acceptance aspects City or county governments, special districts. state agencies, private firms, and intergovernmental organizations may be capable of carrying out these responsibilities

The advisory group can help identify and resolve issues related to the institutional arrangements.

A project may lead to secondary impacts such as growth spurred by wastewater treatment facilities These impacts can have long-term financial implications They can be anticipated and dealt with in a financial-institutional plan

The water quality plan should include a financial-institutional element that allows local officials, policy makers, and citizens to determine who pays, how much, and when The advisory group should engage in and review the efforts of the participating agencies to make sure that projected annual capital and O,M&R costs, funding sources, household costs, and secondary impacts are included in the plan

Rehabilitation of Sewers

Buncombe County, North Carolina

The problem was over 50 years in the making—three million feet of dilapidated sewer pipe in Buncombe County, North Carolina. As a result of poor maintenance over the years, infiltration and inflow caused the hydraulic flow at a central wastewater treatment facility to triple during rain storms. Associated water quality and health problems were compounded by the institutional situation. More than a dozen wastewater collection systems were involved.

Buncombe County is a mountainous area of 150,000 people in western North Carolina. The public and private institutions providing wastewater collection and treatment include the Metropolitan Sewerage District (MSD) which owns the major interceptor sewers and the treatment plant. Buncombe County, the City of Ashville, small communities, private church groups.

The Issues

The MSD, under a planning grant from the U.S. EPA, studied the problem and completed a facility plan. The most cost-effective alternative is the rehabilitation of the collection system, rather than an expansion of the existing facility to treat the increasing hydraulic flows. However, in this case cost effectiveness alone may be an insufficient test of plan feasibility. Financial, institutional, and legal issues may thwart local efforts.

Financial Issues

- Which sewers can be economically rehabilitated and to what standards?
- What is the best way to allocate costs, considering equity, institutional responsibility, and financial feasibility?
- What should be done about persons who may not be able to bear their share of the costs?
- What will happen when the charges to system users are raised?
- How can the project be funded?
- How can phasing in the rehabilitation program affect the timing of revenue requirements?

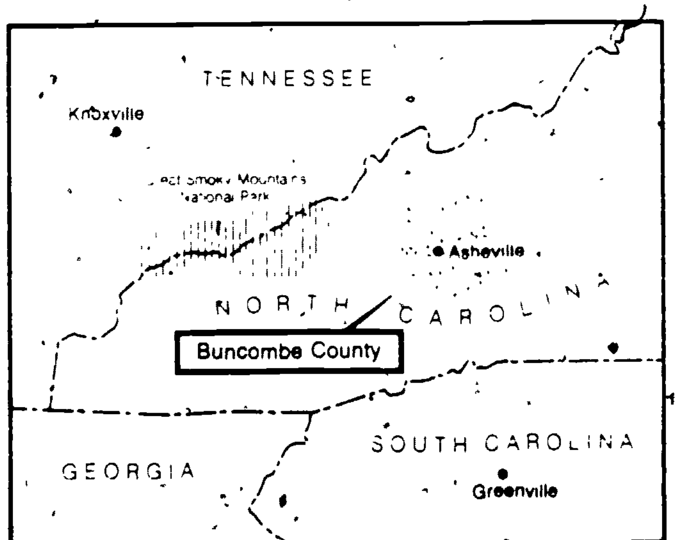
Institutional Issues

- How can the community resolve the conflict of local and federal ownership policies?*
- Can the county and city work out an agreement where costs are equal among residents while EPA regulations require that each entity pay its *proportionate* share?

Legal Issues

- Who owns the sewer lines and/or the rights of way for access to the sewer lines?
- How long will it take and how much will it cost to determine the easements for sewer rights of way?
- How will this process affect the overall project?

**The EPA requires that sewer lines be publicly-owned prior to a grant award; the MSD has a policy that it will not assume ownership of the lines until they have been rehabilitated.*



The Solutions

To address the issues, the Land-of-Sky Regional Council established the Buncombe County Collector System Management Task Force. Consisting of representatives of each of the affected parties, the task force sought consensus by bringing together the various parties.

The task force approach included the following elements:

- The MSD provided legal opinions concerning the acquisition of rights of way, and developed standards for the rehabilitation of collection lines
- A survey of cost information was conducted to identify the sewer lines that could be economically rehabilitated
- Existing costs were identified and translated into figures which the policy makers and general public could easily understand
- A public participation program was launched
- The EPA provided information on securing and administering grant funds
- An inventory of the current institutional and financial characteristics of each of the parties was undertaken, which included existing water quality policies, service charges, other fees, current debt, budget, capital costs, funding possibilities, and financial arrangements
- An institutional assessment was conducted to determine the responsibilities of each participant both during the sewer rehabilitation and afterwards
- The allocation of total shared system costs among various entities using different funding schemes was addressed
- Funding scenarios were proposed and studied

The Results

At this time, the rehabilitation of the collection lines appears feasible. A financial plan must still be formulated which will reflect the analysis and the political concerns of the various parties. For example, the private church groups have virtually no sources of outside funding; federal and state funding assistance cannot be used to rehabilitate these lines unless the private systems come into public ownership. The question thus remains: Is Buncombe County willing to assume ownership of the private lines on an interim basis, as well as assume the management responsibility for the purpose of receiving federal and state construction grant funds for rehabilitation? The ability to use Buncombe County's high bond rating to finance the local share makes this approach attractive. However, arrangements will have to be made between the county and the private church groups for gradual payback to the county of the proportionate share attributable to rehabilitation of the private lines owned by the church groups. Additionally, ownership of the county-owned lines will have to be transferred to the MSD. These and other issues to be reflected in the financial plan will be the topic of future discussions.

Significance of Events

Although the Buncombe County Collector System Consolidation Program has not yet been completed, a number of lessons can be learned.

First, planning for wastewater programs involving two or more parties is complicated by numerous technical, financial, institutional, legal, and political issues. These issues should be identified early in the planning process.

Second, even though the planning advisory body may consist of elected representatives or spokespersons of the participating jurisdictions, it should not be assumed that the views, expectations, or positions of the individual representatives necessarily reflect those of their respective organizations. Additional means of keeping local bodies informed seem advisable.

Third, information and data presented to the public, advisory committees, and legislative bodies should be appropriate to their level of understanding. In this case, there was an initial tendency for some task force members to ask only for summary information, such as the monetary cost for each participant. Providing this information directly without first addressing the underlying issues might have caused some parties to reach premature conclusions. The planning process should proceed in a manner where information is dealt with at a rate that allows for thorough debate and an understanding of all issues.

Fourth, there is a sequence for developing financial information in planning for wastewater programs. This sequence is as follows:

A. Development of wastewater system cost data that is useful in the local decision-making process, as well as for comparing technical wastewater treatment alternatives

B. Identification of all possible funding sources

C. Identification of agency responsibilities and other institutional arrangements

D. Development of a financial plan that shows the proposed participating agencies, gives a summary of their responsibilities, estimates the annual capital and operating costs, and explains the methods of financing

E. Identification of the secondary impacts of the proposed program

Need More Information?

Environmental Planning The Role of Financial Analysis Draft Washington, DC: U.S. Environmental Protection Agency. Financial Management Assistance Program, May 1980

This document describes the importance of incorporating financial analysis into the environmental planning process. Some of the major principles of financial analysis are discussed. Copies can be obtained from the Municipal Finance Officers Association, Government Finance Research Center, 750 K Street NW, Suite 650, Washington, DC 20006

Financial Systems, Proposals, Price Analysis, Negotiations, Grant Administration. Fair Oaks, CA Cilren Co., 1979

The materials in these three handbooks were prepared especially for seminar and workshop training sessions The sample forms in these documents can be used by a management agency in the preparation and analysis of grant proposals and in the administration of projects Copies are available from The Cilren Company, 9912 Fair Oaks Boulevard, Fair Oaks, CA 95628 The cost is $53 00 per handbook

Planning for Urban Stormwater Management Financial Issues and Options Draft Washington, DC U S Environmental Protection Agency, Financial Management Assistance Program, May, 1980

This workbook is designed to serve as a guide for urban stormwater planning and management It emphasizes financial issues of concern both to persons who play a role in the implementation of plans at the local level and to those who bear the costs It is intended for use by agencies, organizations, and individuals involved in the planning for stormwater management. Copies can be obtained from the Municipal Finance Officers Association, Government Finance Research Center, 750 K Street, NW, Suite 650, Washington, DC 20006

Rastatter. Clem L, ed *Municipal Wastewater Management Citizens Guide to Facilities Planning* FRD-6 Washington, DC U S Environmental Protection Agency, Office of Water Program Operations, January 1979 263 pp

This handbook is designed to acquaint citizens with important decisions that need to be made in municipal wastewater management The book lists key decision points throughout the planning process that are crucial to the facility plan and the community It points out environmental, economic, and social considerations affecting these decisions. It facilitates citizen input and helps citizens understand the legal tools for their involvement It is available free of charge from the General Services Administration (8BRC), Centralized Mailing Lists Service, Building 41, Denver Federal Center, Denver, CO 80225

Small Community Wastewater Systems Financial Guidelines for Planning and Management Draft Washington, DC U S. Environmental Protection Agency, Financial Management Assistance Program, May, 1980

The workbook is a user-oriented document It includes many illustrations and tables Its purpose is to highlight the major financial issues in planning for wastewater treatment facilities. It suggests a five-step procedure for financial analysis It can serve as a primer for planning process participants such as project engineers and advisory groups Copies can be obtained from the Municipal Finance Officers Association, Government Finance Research Center, 750 K Street, NW, Suite 650, Washington, DC 20006

U S Environmental Protection Agency. General Grant Regulations and Procedures, Title 40 Code of Federal Regulations, Part 30 *Federal Register*, Vol 43, No 127, June 30, 1978, pp 28484 - 28489

This document presents the specific rules and regulations which must be met when applying for a sewage facilities construction grant Copies are available for $1 00 each from the Office of the *Federal Register*, National Archives and Records Service, Washington, DC 20408